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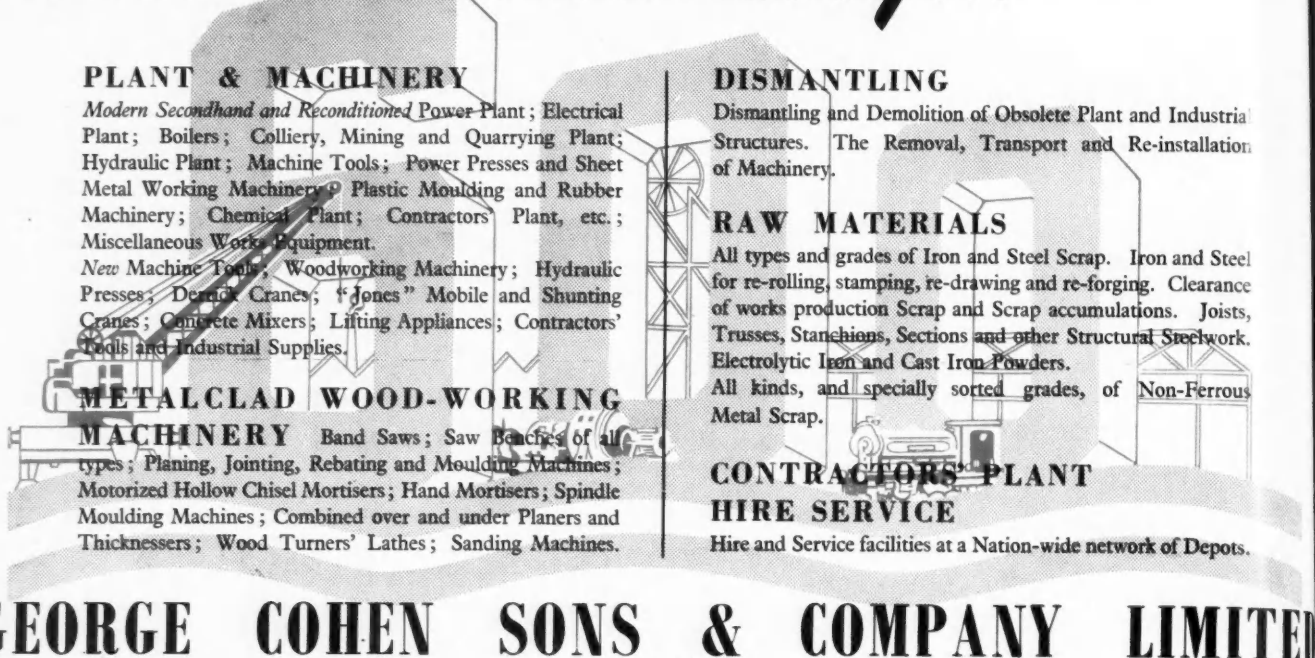

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A Seven-Day Journal

Forthcoming Retirement of Sir Henry Guy, F.R.S.

THE Institution of Mechanical Engineers has announced this week that the Council has received with regret the resignation of the Secretary, Sir Henry Guy, C.B.E., D.Sc., F.R.S., on the grounds of ill-health. The resignation will take effect from December 31st next. Sir Henry has had a long and distinguished career in mechanical engineering, which began with a pupilage under the late Mr. T. Hurry Riches, Chief Mechanical Engineer of the Taff Vale Railway. From 1907 to 1910 he studied at the University College of South Wales, where he gained the College diplomas both in mechanical and electrical engineering, taking the two courses simultaneously, and he also won the Bayliss Prize of the Institution of Civil Engineers, a Royal Research Scholarship and a Whitworth Exhibition. In 1910 Sir Henry joined the technical staff of the British Westinghouse Company, and in 1915 was appointed its centrifugal pump and turbo-compressor engineer. He became chief engineer of that company's successor, the Metropolitan-Vickers Electrical Company, Ltd., in 1918, a post which he retained until 1941, when he was appointed Secretary of the Institution of Mechanical Engineers. Just before the war, in 1939, Sir Henry was invited to join the Advisory Council on Scientific Research and Development of the Ministry of Supply and later became Chairman of its Gun Design Committee and of its Static Detonation Committee (Bombs). Early in the war the Minister of Supply appointed him to be Chairman of the Committee on Armament Development, and, in addition, Sir Henry subsequently presided over other committees concerned with armament research and development and the technical organisation of the Forces. He has also served as chairman and a member of various post-war committees set up by the Ministry of Supply's Scientific Advisory Council. Since 1944 Sir Henry has been a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, and in 1945 he became Chairman of the D.S.I.R. Committee on "The Essential Requirements for Research in Mechanical Engineering," and was later appointed Chairman of the Mechanical Engineering Research Board of the D.S.I.R. Sir Henry was created a knight in the New Year Honours of 1949. He became a graduate of the Institution of Mechanical Engineers in 1906, an associate member in 1912 and a full member in 1927. He was elected a Vice-President in 1938, an office which he relinquished on taking up the Secretaryship. Sir Henry was elected a Fellow of the Royal Society in 1936 and received the honorary degree of D.Sc. of the University of Wales in 1939. In the same year he was invited by the Royal Society and the Institution of Civil Engineers to give the fourth Parsons Memorial Lecture and was awarded the Parsons Gold Medal. There are many readers who will join with us in regretting the reason for Sir Henry's resignation from the Secretaryship of the "Mechanicals" and in wishing him a speedy recovery of good health.

Integration of Freight Transport Services

ON Thursday of last week the British Transport Commission made a statement outlining its future policy for the integration of road and rail transport. The Commission claimed that with the acquisition of road haulage now virtually complete it was able to exploit fully the new relationship between road and rail transport, now relieved of its former rivalry. The Commission thought it immediately necessary to restrict travel facilities to that form of transport to which a particular product lent itself most economically. In this direction, the statement said, rail transport was thought to be most suited for the conveyance of bulk minerals and ores which normally required full-haul loads, regular long-distance freight not requiring intermediate shunting, grain and feeding materials for which storage could be provided at termini; and it was also particularly suitable where an immediate clearance of materials was necessary either at dock sides or industrial production yards. On the other hand it was felt that road transport could be most suitably employed if relegated to the disposal of local haulage, to loads restricted by the railway gauge, to removals requiring skilled and personal supervision, and to loads of longer haulage but not proximate to a railhead. The statement went on to suggest that the extensive development of rail termini was envisaged, to and from which road transport would feed and distribute. It was hoped eventually to provide radial distribution on these lines for individual firms. Such an integration, it was claimed, would not overlook the distribution of certain special commodities. Perishable goods were thought by the Commission to be better served by a long-distance road haulage fleet. It was hoped also to integrate the services of inland waterways.

Road Fund Report 1948–49

IN the report on the administration of the Road Fund for 1948–49, published last week, it is stated that the programme of road works for the year was cut down to conform with the restriction of capital investment. Payments from the Road Fund for maintenance, improvement and construction of roads in 1947–48 amounted to £24,700,000, of which £8,515,000 referred to trunk roads, the corresponding figures for 1948–49 being £22,300,000 and £7,916,000 respectively. Of the money spent on trunk roads, some £6,240,788 was allocated to maintenance and minor improvements, including the surface dressing of 13,442,000 square yards and resurfacing the worst sections of the busiest roads, amounting to 512 miles. The report reviews the average cost per mile of road and gives £152 in 1945–46 and £241 in 1947–48. During last year only important works necessary to maintain essential road services for the export drive and to remove dangerous conditions were undertaken and the labour force of 95,000 was reduced by nearly 20,000. It is estimated that the volume of maintenance work amounted to approximately 60 per cent of the average for the years 1936–39.

Launch of "Ocean Monarch"

THE twin-screw cruising liner "Ocean Monarch," built by Furness, Withy and Co., Ltd., was launched from the Naval Yard of Vickers-Armstrongs, Ltd., on July 27th, the ceremony being performed by Lady Essendon. Of 14,500 gross tons, this passenger and cargo liner conforms to the new Safety Convention regulations and has been built to replace the "Monarch of Bermuda." Speaking after the ceremony, Sir Ernest Murrant, the chairman of the owning company, had something pertinent to say concerning replacement costs and the incidence of taxation and offered a suggestion for the solution of the problem. Quoting facts relating to the two ships, he stated that the decision to build a new ship instead of paying tax on money recovered from insurance policies on the old ship meant that wear and tear allowances to the same capital amount must be deducted from the first cost of the new ship. In effect, the tax relief on the "Ocean Monarch" would be calculated on about one-half of the first cost. Sir Ernest felt that this was an iniquitous handicap and it called for the abolition of the balancing charge in respect of ships lost by either marine or war risk. While realising that shipping earnings could not receive exceptional treatment for the purposes of taxation, he mentioned that Chancellors in other countries had not shirked this issue. Continuing, Sir Ernest was emphatic in stating that old and worn-out ships could not be replaced by shipowners under the present rate of taxation and methods of assessment. To alleviate the situation, he suggested that the portion of taxation raised from assessment on reserves set aside for tonnage replacement should be held in escrow and that shipowners should be able to draw on this fund to defray in part the cost of new replacement tonnage.

The International Mechanical Engineering Congress

THE third International Mechanical Engineering Congress is to be held in Brussels from September 18th to 23rd. It is being organised by trade associations in Belgium, Denmark, Finland, France, Great Britain, Holland, Italy, Norway, Sweden, and Switzerland, the chairman this year being Monsieur L. Bekaert, President of the Fédération des Entreprises de l'Industrie des Fabrications Métalliques, Belgium. The theme of the Congress discussions is "Quality," and the papers which are to be presented will deal with the various elements which contribute to the improvement of quality in mechanical engineering production. The papers and their subsequent discussions are to be supplemented by a series of visits to representative engineering works in Belgium. Among the subjects to be studied at the Congress, the programme mentions design and manufacturing processes; the selection of raw materials; control at various stages of manufacture; influencing customers' requirements; the part played by the human factor, and the "educative action" of trade associations and Governments in matters of quality. The British Engineers' Association, 32, Victoria Street, London, S.W.1, is responsible for British participation in the Congress. Among those presenting papers is Mr. H. Ward, M.Sc., Secretary of the Industrial Management Research Association of Great Britain, whose subject is "The Influence of the Human Factor in Achieving Quality Production." The Congress sessions will take place in the lecture room of Fabrimetal, 21, Rue des Drapiers, Brussels.

The Air Registration Board

LORD PAKENHAM, Minister of Civil Aviation, made a statement in the House of Lords on Wednesday of last week about the future of the Air Registration Board, in the light of the recommendations of the Helmore Committee. The principal recommendations of that Committee, it may be recalled, were that the Air Registration Board's annual deficit should be met from public funds and that the Board itself should be reconstituted, the members being appointed by the Minister instead of being nominated by aviation interests, such as constructors, operators and insurers. Lord Pakenham said that, since the publication of the Helmore report, his Ministry had had discussions with the Board, which had resulted in a financial reorganisation. The Ministry had agreed to refund the cost of certain services performed by the Board on its behalf, and certain statutory fees, notably those for prototype aircraft, had been increased. By those arrangements it was estimated that the Board's deficit would be reduced to small proportions, and contributions to the annual deficit—if any—would be made in agreed proportions by the Ministry and the independent guarantors. In those circumstances, Lord Pakenham continued, he had decided that there was no need to reconstitute the Air Registration Board and that the harmonious relationship which now existed between it and the aviation interests concerned would best be preserved by retaining its present independent status. Lord Pakenham added that he was satisfied that the Board, under the chairmanship of Lord Brabazon, was most competent in the highly technical field in which it laboured. It had rendered outstanding service, he said, in the establishment of post-war standards of airworthiness.

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FIG. 6—HEADER FACTORY FORGING BAY

FIG. 7—HEADER FACTORY MACHINING BAY

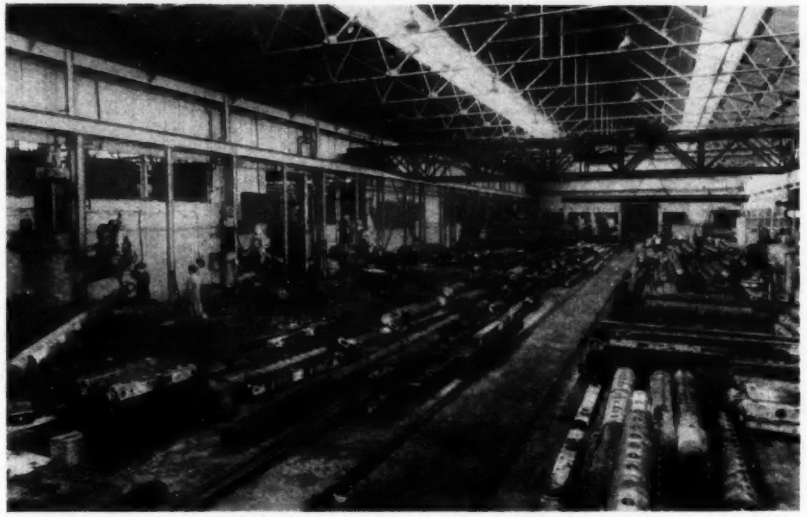

FIG. 8—SECTION FACTORY

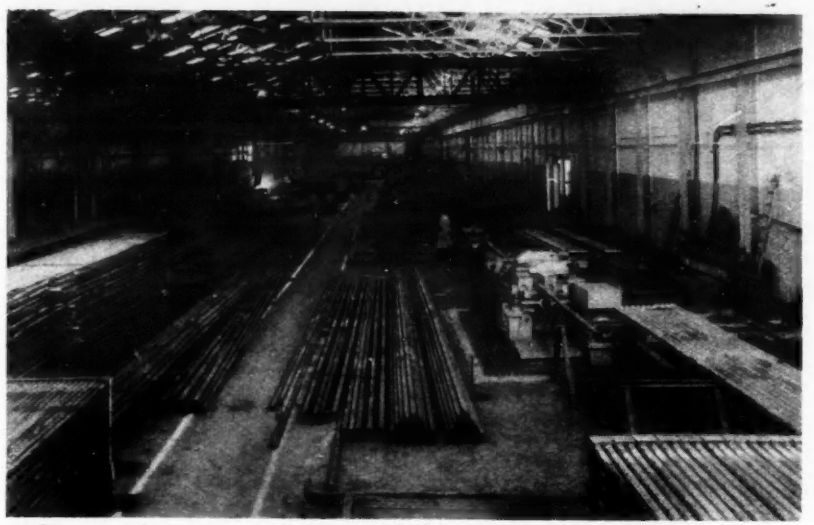

FIG. 9—SECTION FACTORY—TUBE BAY

Productivity in British Industry*

No. VIII.—WORKS EXTENSIONS—PART II

By C. K. F. HAGUE†

HEADER FACTORY

THE lay-out and production flow lines of the header factory are shown in Fig. 10. There are four bays, so arranged as to permit continuous production from operation to operation, commencing with the piercing and drawing of heavy wall seamless tubes. This factory was originally laid out for the production of the well-known Babcock and Wilcox forged sinuous header, which was gradually modified over a period of years as the pressure and size of boilers increased. At the present day, however, the plant is laid out for the manufacture of headers and collector boxes of all types required in the construction of a steam generating unit, and this includes collector boxes on furnace water walls, superheaters, economisers, &c., as well as the many connecting headers required in present-day design.

The billets from the steel makers are received in Bay 1, which is the forging bay (Figs. 6 and 10), and are reheated in a continuously fired producer gas furnace and forged into rectangular boxes or tubes having a predetermined length and wall thickness. From this operation the rolled blanks are taken to the staggering section in the same bay, where they are reheated and forged into the specified sizes of header, of which a wide variety can be produced to suit the design of boiler for which the header is required. From this stage the ends of the headers have to be closed and this operation is performed at the end of Bay 4. The plant consists of small vertical presses, in which the ends of the headers are converted from rectangular to circular cross section preparatory to the final closing. The ends of the headers at this stage are reheated and the end closing machine, which is of special design, closes the ends by spinning-in the wall of the header. The shot-blast plant exists for the removal of internal and external scale, and after inspection the work is transferred to the assembling and grading benches preparatory to passing to the machining section (Fig. 7). This section is situated in Bay 2, and the machines are so placed as to permit a continuity of machining operations. The material handling in this shop is by a number of monorail cranes

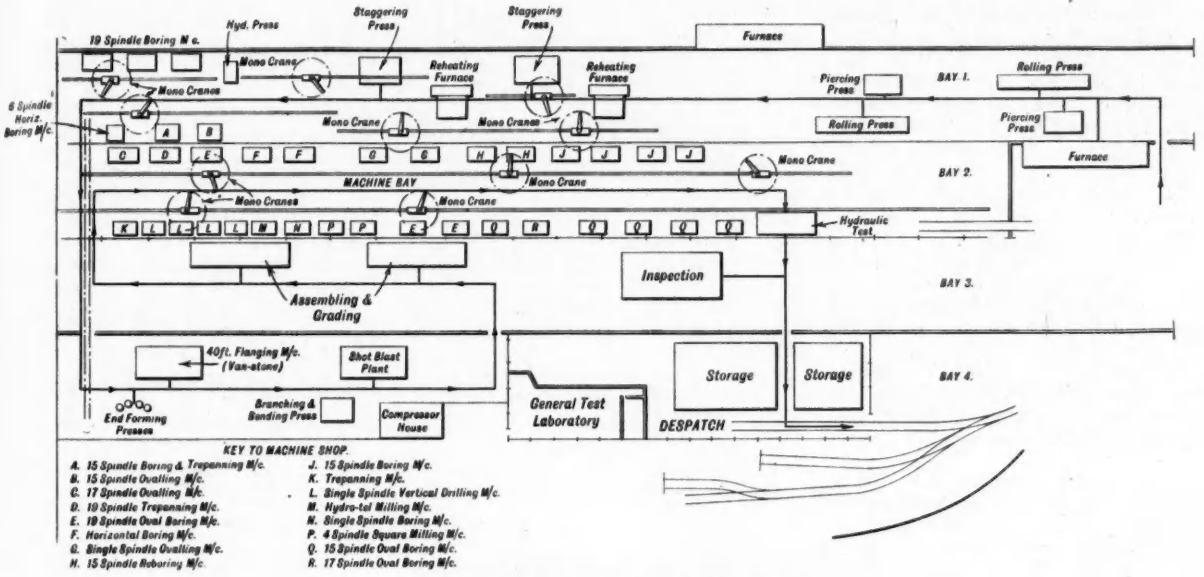

FIG. 10—LAY-OUT OF HEADER FACTORY

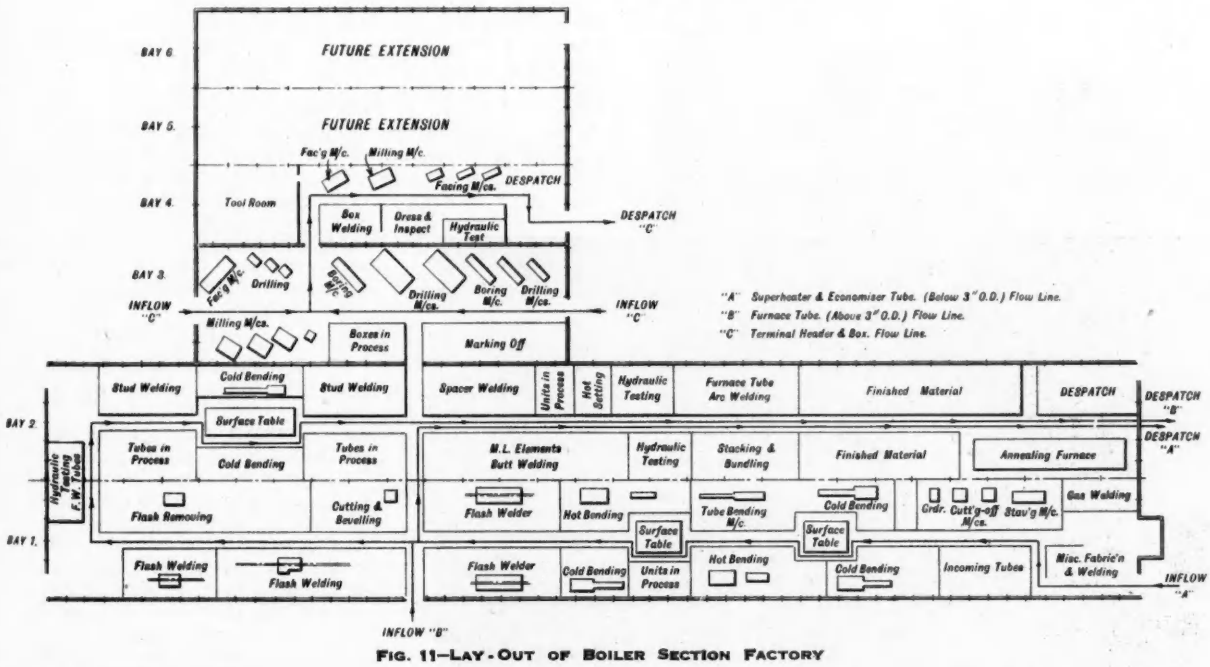

FIG. 11—LAY-OUT OF BOILER SECTION FACTORY

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* No. I, "An Introductory Survey," by B. White, appeared February 17th; No. II, "The Threshold of Productivity," by F. A. Martin, March 3rd; No. III, "High Productivity and Production Costs," by Sir Claude Gibb and Gordon M. Baker, March 17th; No. IV, "Standardisation in the Aircraft Industry," by E. C. Bowyer, March 31st; No. V, "Restrictive Practices," by Arthur Woodburn, April 21st; No. VI, "Research for Productivity," by Dr. D. F. Galloway, May 19th; No. VII, "Consequences of Simplification," by W. D. King and H. Sherburn, June 30th.

† Managing Director, Babcock and Wilcox Ltd.

running parallel to the lay-out of the machines, and a fast transfer of product from machine to machine is obtained. After machining, the headers are hydraulically tested, and after inspection are ready for transfer to the section building department for insertion of tubes or, alternatively, for shipment as loose headers.

Section Factory

A " section " in boiler language is regarded as a series of lengths of tubing either straight lengths or with short radius bends at the ends, terminating in an inlet and an outlet header, and located somewhere in the path of the hot gases passing through the boiler unit. A substantial volume of the productive work in the factory embraces the flash welding of tubes into long lengths and manipulation into all shapes. The lay-out of the factory and the flow lines are shown in Fig. 11 and the distribution of various classes of work may be summarised as follows :—

(*a*) The manipulation of small-bore tubing up to 2½in diameter required for the construction of superheater and economiser elements, coils for attemperators, and oil heaters, and such other boiler tubes as come within this category.

(*b*) The manipulation of large-bore tubing between 2½in O.D. and 4in O.D., which embraces bare furnace tubes, Bailey wall furnace tubes, baffle tubes, generator tubes and recirculators.

(*c*) The machining of headers and collector boxes other than those completed in the header factory. These include boxes of square or round section, with tube holes and internal hand hole fitting seatings, which require the addition of welding of lugs and brackets.

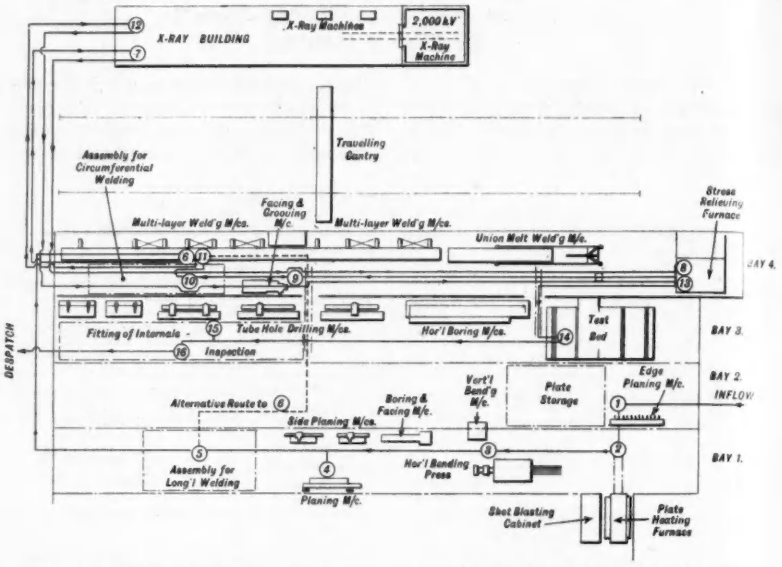
(*d*) One section of the shop is employed in the attachment of studs or fins to tubes by resistance welding. This type of tube is required on many types of up-to-date steam generating plant where extended heat-absorbing surface is needed.

Consideration has consistently been given to the balancing of the load in this department with the fluctuating demands for varying types of components passing through the shop at any one time.

When dealing with boxes or headers it had to be recognised that both diameter and length have considerably increased in recent years, and boxes up to 45ft in length have to be handled. To balance box production with tube requirements additional duplex drilling and boring machines have been installed, and these machines were devised to complete all the necessary operations associated with tube holes with a minimum of handling and setting up (Fig. 8).

It will be obvious with this class of work, in which it is necessary to bend to very close limits and into all shapes tubes up to 60ft and more in length that the work done per unit of floor area is relatively small (Fig. 9). In order to conserve floor space as much as possible consideration is being given to the best means of reducing interference when work in progress is being moved about the shop. This object has been achieved to some extent by introducing jigs or manipulators on which tube elements or other units can be set up (Fig. 12), and which can be manually or mechanically moved into various positions for fabrication. This arrangement has reduced considerably the overhead crane requirements. The maximum amount of floor space is devoted to productive work, and feeder supply squads are held responsible for bringing material into the production area at the right time. A feature of this factory is that it has a tool room annexe, which constantly supplies small tools and component parts and ensures a continuity of work. This provision is closely associated with the main machine shop supply, but functions with a degree of independence to be closely integrated with the production line in this shop.

The tendency with the modern boiler is to incorporate tubes of a gross length of 100ft and more and the manipulating of individual tubes 60ft to 70ft long, which are welded together at site, brings increasing problems to this section of the works.



1.—Plate reception, inspection and preparation
2.—Plate heating
3.—Plate bending or rolling
4.—Long weld groove preparation
5.—Cylindrical shell assembly
6.—Long seam welding
7.—X-ray examination of welding
8.—Stress relieving
9.—Circumferential weld groove preparation
10.—Assembly of courses or heads
11.—Circular seam welding
12.—X-ray examination of welding
13.—Stress relieving
14.—Hydraulic testing
15.—Tube hole drilling
16.—Fitting of internals, inspection and despatch

Fig. 13—Lay-Out of Drum Shop

Fig. 12—Tube Element Jig

Drum Shop

The lay-out of the drum shop is indicated in Fig. 13 and, in view of the fact that an article appeared in the March 31st issue of The Engineer on the manufacture of fusion-welded boiler drums and pressure vessels, it is not proposed to describe this shop in detail.

The flow of material is indicated clearly in the drawing, and it is interesting in this connection to point out that the 8000-ton press, which was installed in 1928, was originally designed for cold bending of plates of the order of 2½in thickness, 40ft long, for riveted drums, whereas it is now utilised for hot bending of plates of any thickness, with a maximum length of 40ft for fusion-welded drums. The gradual change over from riveted drum construction of fusion-welded drum construction since 1931 has necessitated many modifications to the lay-out of this shop, and when the final arrangement as now indicated was made it was necessary to take into account the position of the 8000-ton press, the vertical bending press, the welding heads, and the position of the stress-relieving furnace, as well as that of the heavy multiple-spindle drilling machines. Furthermore, in the new lay-out it was found necessary to remove the X-ray examination of drums into a completely new building, and to

increase the capacity of the X-ray installation—all of which is described in the article referred to above.

Conclusion

It will have been seen that many factors govern the changing lay-out of a heavy engineering works such as Babcock and Wilcox, Renfrew. Particular attention has been drawn to progress of design and its effect on lay-out and production. The steady rise in operating pressures and temperatures has necessitated the adoption of much closer tolerances in machining and assembly operations than was the case years ago, whilst the need for special steels to withstand high-temperature service requires closely controlled heat-treatments, all of which have materially increased the man-hours of work expended on each ton of boiler material produced. This is an aspect which cannot be over-emphasised in considering the advancement in boiler manufacture and in comparing past outputs with those of the present day.

North of Scotland Hydro-Electric Schemes*

No. II—THE LOCH SLOY PROJECT

Part III—*(Continued from page 91, July 28th)*

Control of Water

THE normal daily control of the operation of the turbines is effected by valves in the power station, but the flow is also controlled at the main tunnel intake and at the top of the pipe-line, and can be stopped at either of these points.

The illustration (Fig. 4, page 58, July 21, 1950) of the upstream face of the dam shows the intake to the main tunnel at the bottom of the upstream face of the valve tower. A cross section through the valve tower is also shown herewith (Fig. 17). The water first passes through a coarse fixed bar screen of large area to prevent the ingress of large debris. Behind this screen, across an opening 20ft wide and 25ft high, there is a finer lifting screen, weighing 15 tons, which can be raised for cleaning by an electrically-operated winch along metal guides and wheel tracks cast into the concrete of the valve tower. A series of horizontal metal trays is fitted to catch any debris which may fall away from the screen. Indication that the screen requires cleaning will be obtained from pressure gauges, read at the power house.

The entrance passage downstream of the screens contracts gradually to a section 19ft high and 10ft wide, where there are two gates, a guard gate and a control gate, to control the flow of water into the tunnel. The upstream one, the guard gate, is normally housed inside the gear house at the top of the valve tower above top water level. The purpose of this gate is to stop the flow in an emergency, if the control downstream has failed, or to allow the valve shaft to be emptied for inspection and maintenance, and for maintenance of the control gate.

The guard gate is of the tube rolling type and weighs about 35 tons. It can be raised by an electric winch and wire rope in metal guide grooves which are on the outer upstream side of the gate well. A force of about 90 tons is required to crack open the gate, due to the water load acting on top of it. Both gates support a maximum water load of nearly 1000 tons by spanning horizontally across the 10ft width of the well. The control gate is a free roller gate, built of mild steel. It is counterbalanced and can be raised by electric winch or an alternative hand gear.

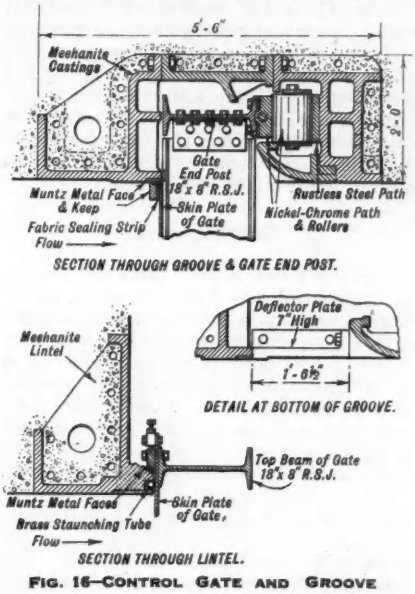


FIG. 16—CONTROL GATE AND GROOVE

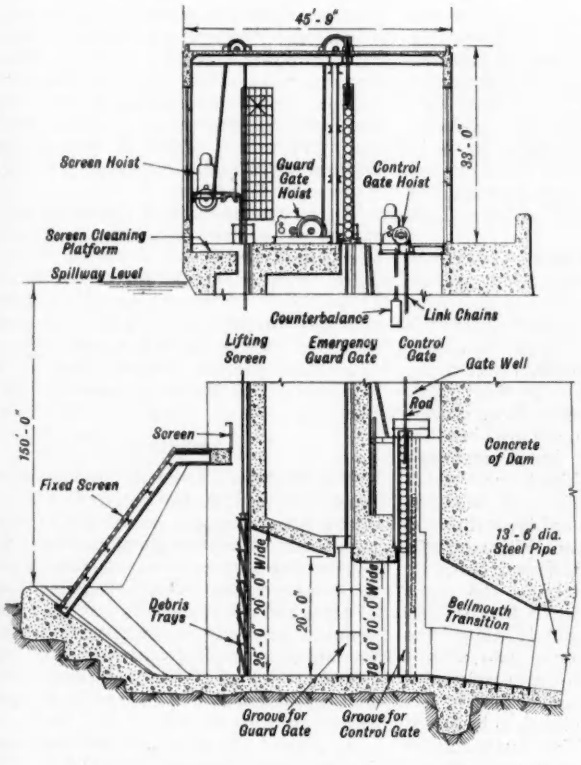


FIG. 17—SECTION THROUGH VALVE TOWER

FIG. 18—CONCRETING PLANT AT DAM SITE—AUGUST, 1948

The bell-mouthed entrance to the 13ft 6in diameter steel pipe leading to the main tunnel commences downstream of the control gate. The design of the control gate presents several points of interest, and the detailed description of the gate in the next section of this article has been reproduced from a recent paper by Mr. Williamson.†

Control of the reservoir water is also effected at the dam by the spillway, which

* No. I, "An Introductory Survey," appeared July 14th.

† "Loch Sloy Hydro-Electric Scheme: Pipes, Valves and Water Control Gear," by James Williamson, M.I.C.E., December 13, 1949, Institution of Engineers and Shipbuilders in Scotland.

has been described earlier, and by a scour pipe for emptying the reservoir, which is built into the centre buttress of the spillway. This pipe is 4ft in diameter, and is provided with a screen and guard gate at its upstream end, and a hand-operated disperser needle valve at the downstream side. The guard gate is similar to the main guard gate described above, and is provided for emergency operation only. When the disperser needle valve is in operation, the discharge falls as a heavy spray on the stilling pool.

Control Gate

The conditions of flow, head and loading at the control gate form almost an exceptional combination and the design and details of the gate deserve more than a cursory remark. The body of the gate is designed for stiffness as well as strength and consists of a facing of $\frac{5}{8}$in steel plate supported by horizontal steel beams 18in by 8in, spaced at 1ft 3in centres from top to bottom. These beams carry the water pressure load across the span of the opening. At each end the beams are extended beyond the plating and are framed into 18in by 8in steel beam end posts, 21ft 4½in high, and spaced at 12ft centres. These end posts gather the whole load on the gate and form a first link in the chain which transfers it through the rollers to the concrete of the dam. It is necessary to provide central loading for the rollers in order that they may bear evenly on the roller paths and to effect this a rocking roller path is interposed between the end post and the rollers. A shallow groove machined to a circle down the centre line of the bearing flange of the end post forms a socket in which a turned projection along the middle of the roller path can rock and thus maintain central loading. The heavy roller path, 8in wide, is attached to the end post with sufficient play for the rocking, and is of nickel-chrome steel. It bears against a train of twenty rollers of solid nickel-chrome steel 8in in diameter by 9in in length, bored out to receive nickel-chrome axles having loosely fitting cupro-nickel sleeves. The axles serve to string the rollers into complete trains on side plate frames which move with the rollers. The rollers are turned and finished to limits of $\pm 0{\cdot}001$in. The average load to be transmitted through each roller is about 21 tons. The transmission of the load from the rollers to the side walls of the gate well is through another fixed roller path of rustless steel attached to a machined face on the heavy box-section Meehanite side framing of the opening. The framing itself is solidly fixed in the rich concrete of the side walls of the well, through which the load passes ultimately into the mass of the dam.

The gate in rising bears against the rollers which roll freely on the paths and travel up at half the speed of the gate. The roller train has pulleys at the top which are supported in the bight of chains attached at one end to the top of the gate and at the other end to the top of the gate groove some 20ft above the opening. This two to one purchase ensures that the pulleys travel up at half the speed of the gate to correspond with the rolling speed, and the trains remain in suspension.

Grooves or recesses in any opening conveying high-speed water can create gross disturbance of the flow with attendant ill-effects and suitable mitigating means are called for in some instances. In normal operation with the control gate open the speed of flow is not exceptional, about 11½ft per second but sufficiently high to require special protection of the roller trains, the lower half of which then hangs below the gate and comes within the influence of the flowing stream. To prevent displacement or shaking of the roller trains the groove castings are shaped and arranged to allow the water to pass with minimum disturbance. They also act as guides with small clearance to restrict lateral movement of the rollers. Fig. 16 is a section through a groove showing the stowing of the rollers and the guiding forms adopted.

While the flow conditions are not too severe under ordinary operation, it is different when the gate is opened a little at full reservoir head for the refilling of the tunnel. The water then spurts through under the gate at the full velocity due to the head of about 165ft, that is, about 103ft per second, and if the gate were opened too much the effects could be alarming, both hydraulically and pneumatically. An opening of a few inches will, however, serve for the gradual filling of the tunnel under safe conditions, and by means of a limit switch and other automatic arrangements, the gate is prevented from rising more than the desired amount (rather less than 6in) until the tunnel is filled, and the water has risen some distance up the shaft to operate a release switch. A flow of 103ft per second past a groove could cause violent chattering of any suspended part, such as the lower end of the roller train. The small amount of the cracking-open which is required, however, enables a special device to be used at the bottom which could not be applied to any major portion of the height of a groove. The gate is arranged at the bottom with the end post clear of the plating and projecting below the lowest cross-beam, so that in closing it can drop into a protected section of the groove. This enables the side wall of the channel, formed at this place by the Meehanite groove castings, to be made completely flush for a height of 7in above the sill. This is sufficient to make the conditions safe for the restricted height of jet at high cracking velocity.

The plating at the bottom of the gate extends below the bottom beam and is reinforced and machined to make close contact with a rustless steel bearing plate fixed on the sill casting. The methods of sealing the sides and lintel are probably advances on previous practice. At the sides thick rubber-fabric strips in angle form extend the full height of the gate, are held in place and protected by metal keeps, and rub against Muntz metal machined strips which extend for the whole height of the side frames and the guide frames higher up, that is, twice the height of the gate. When the gate closes the fabric strips are forced home by hydraulic pressure to staunch the angle between the gate and the side frame. The staunching across the lintel is one of the most difficult problems in a gate of this nature. For the Sloy gate main reliance is placed on a brass tube retained loosely in a recess at the corner of the lintel to be forced into staunching contact with the gate and the lintel when a pressure difference develops. In addition, the upper part of the lintel casting next the gate has a sloping machined Muntz metal facing matched by a similar facing carried on an upstream projection attached to the top of the gate. When the gate is lowered to the bottom the facing on it comes down over the facing of the lintel and sealing depends on a combination of accurate fitting and the retarding effect of a fine zig-zag passage for the water if the fitting is not quite close.

The setting of the gate on the upstream side of the well away from the dam has a number of advantages. When the gate is shut and the water drawn off, access is available to it and the tunnel by the flights of ladders and platforms provided inside the well. Ample means is thereby also provided for ingress or egress of air as the tunnel is emptied or filled. When the control gate is cracked open for refilling the tunnel the well is dry and there is no water load on top of the gate to increase the opening effort. This diminishes the force required to open the gate by some 60 tons or 70 tons as compared with a gate placed against the face of the dam. Operation is, therefore, easy, and an 8 h.p. motor serves for the raising or closing at a speed of 4ft per minute. The maximum water pressure on the face of the gate is 836 tons, and a lifting force of 8 tons is estimated to be necessary to overcome any unbalanced load and the frictional resistance of the gate and roller trains. The weight of the gate, less buoyancy, is available for lowering, when the winch acts to raise the counterweight.

Water Control Downstream of Dam

Separate control of the flow in each of the four pipes serving the main machines is obtained from four 7ft diameter disc valves in the valve house at the top of the pipeline. These valves are normally intended to remain open, being closed solely for isolation of a pipe, although in the event of overspeed they have an automatic trip-gear to effect closure. The disc valves are operated by hydraulic servo-motors and can be operated from the valve house or the power station; there is also a hand pump at the valve house for opening or closing the valves without power. A by-pass pipe, 10in in diameter, with a hand-operated sluice valve, has been provided for filling an empty pipe and balancing the pressure before opening the main valve. There is also an anti-vacuum valve and a manhole immediately below each disc valve.

The turbine operating valves at the power station are cylindrical balanced valves, and there are also relief valves leading from the spiral casing of each turbine to the tail race. These relief valves operate in conjunction with the turbine gates and allow automatic escape of water to the tail race when the turbine ceases operation, thus avoiding a sudden stoppage of flow and the consequent water-hammer.

Aqueducts

The diagram of the Loch Sloy scheme reproduced in Part I of this article (Fig. 1), shows the position and extent of the various aqueducts which are being constructed to collect water from the catchment area of 32·5 square miles. A total of about 10½ miles of pipes and open conduits and 12½ miles of tunnels, generally unlined, will eventually be built. A typical open aqueduct has a bottom width of 2ft 9in, a depth of 2ft 6in, and side slopes of 1 : 1 formed by a concrete lining 6in thick.

In general, the cross section of the tunnels is roughly rectangular, varying from 6ft 6in wide by 7ft high to about 9ft by 8ft. The tunnels were arranged so that they would be large enough to accommodate a mechanical loader during construction. In some places reinforced concrete pipes, from 18in to 6ft in diameter, or closed rectangular reinforced concrete conduits, have been employed to form the aqueducts.

Coiregrogain Quarry

The predominant mica-schist rock on the site of the dam at Loch Sloy is unsuitable for concrete aggregate. Two alternative sources of good aggregate were located near the dam,

one consisting of granite, situated at a high elevation about 3 miles north, and the other of grano-diorite (tonalite) in the Coiregrogain Valley about 1½ miles south. Subsequent investigation indicated that the southerly site was preferable for exploitation, and the Board decided to open a quarry at Coiregrogain under its own auspices, and supply crushed aggregate to all the contractors operating in the vicinity. The stone supplied has a density of 185 lb per cubic foot, and the concrete produced from it has a density of about 155 lb per cubic foot.

At the point selected for the quarry, the daily blasting operations bring falls of clean rock, which is collected by excavators and taken by dumpers to the primary crushers. Here, a moving-band feeder, with variable speed control effected by cone pulleys, delivers the stone in a controlled flow to the jaws of the two primary crushers, each capable of receiving rocks 42in by 36in. These crushers incorporate two manganese steel jaws, slightly inclined backwards from the vertical, and the rock falls between them as they open and close. The crusher is composed of massive castings, heavily ribbed; there is a gantry and crane above the jaws so that any extra large pieces of rock accidentally admitted can be removed by rope slings.

The drive is provided by a weather-proof 175 h.p., 725 r.p.m., closed-air-circuit slipring motor, operating at 440V, with liquid resistance speed control in the rotor circuit. Double coolers are fitted, so that the heavily abrasive dust cannot enter the bearings or windings. The capacity for heavy starting and the ability to operate, unprotected, in all weathers, are the main requisites of these motors.

From the primary crusher the rock, now crushed to 8in pieces, is elevated on a 30in wide belt conveyor to a vibrating "grizzly," where any dirt is removed before passing to the secondary crushers, of which there are two. These 4in secondary cone crushers, embody two massive cones, disposed vertically, one within the other, the rock being precipitated into the space between. The inner cone is caused to gyrate rapidly and opposes a spring-loaded crushing bowl. The secondary crushers are driven through multiple vee-belts, by weatherproof closed-air-circuit slipring motors, again of 175 h.p., at 725 r.p.m.

At this stage, the stone is reduced to approximately 2½in fragments, which are taken by conveyor belt and elevated to the screens. Here there are successive vibrating wire meshes on rectangular steel frames through which the fragments fall, and are washed and sorted into 2½in, 1½in, and ¾in sizes, and then taken, again by conveyor, to steel hoppers of 1500 tons capacity to await final transfer by lorry or conveyor belt to the construction sites. Pieces which are too large for the screens are taken back to the second of the two cone crushers to be processed once more.

The water and fines passing through the screens are collected in a receiving hopper immediately below, and conveyed by pipeline to a "sandor," which removes the sand and delivers it to a storage bunker. The surplus water is drained off and delivered to a settling pool adjacent to the burn. The total capacity of the quarry is about 150 tons per hour.

Conveyor Belt

To carry the large quantity of aggregate needed an interesting form of belt conveyor, with a capacity of 120 tons per hour, has been installed between Coiregrogain quarry and the site of the dam. Rising over the brow of Ben Vane, and then descending to the site (as shown in Fig. 18), the conveyor is 1¼ miles long, and is divided into fifteen separately driven sections, each delivering the aggregate forward to the next section. From the quarry site to the top of the brow over which the conveyor passes the total rise is 350ft. The length of each section depends on the gradient of the hillside, and each section is driven by a separate motor, seven being of 25 h.p., three of 20 h.p., three others of 15 h.p., and two of 12½ h.p.

An 11kV overhead line from the diesel station runs alongside the conveyor, and provides the feed to the motors. There are three step-down transformers providing 400V, three-phase current for the motor groups. To ensure that starting and stopping are carried out in an orderly fashion, the motors are started at five-second intervals automatically by time-delay relays. These are controlled by a pilot wire from the dam site end. An emergency stop button is provided at the quarry terminus.

Concreting Plant

At the dam site, the final section of the conveyor is elevated on steel trestles to deliver to stock piles (Fig. 18). These stock piles have a recoverable capacity of about 4000 tons, thus providing a substantial reserve against accidental breakdown. An automatic weighing machine on the last section of the conveyor records the weight of material delivered. When required for use, the aggregates are drawn from the bottom of the stock piles through chutes set in the concrete roof of a recovery tunnel, and a conveyor belt takes the aggregate from the tunnel up to the hoppers of the mixing station.

Sand is delivered to these hoppers from an adjacent stock pile, by derrick. The sand comes from pits at the south end of Loch Lomond, and is towed by barge 20 miles up the Loch to Inveruglas, and then taken 3 miles by road to the dam site. Cement is delivered by road, and stored near the batching plant

The mixing station is equipped with weigh-batching plant, and two 2 cubic yard mixers. The contents of the two mixers is discharged into a 4 cubic yard transfer truck, which is mounted on rails, and is hauled up a slight incline by winch and rope, into position below the cableway. The concrete is then transferred to the cableway skip.

Cableways

The two cableways which span the site of the dam can deposit a skip of concrete containing 4 cubic yards at any point over an area of 8700 square feet. The span of the cableways is 1350 feet, and the tail carriage of each machine can be travelled through a distance of 170ft, which is equivalent to an angle of 7¼ deg. about the head mast. The maximum load on the hook of each cableway is 10 tons.

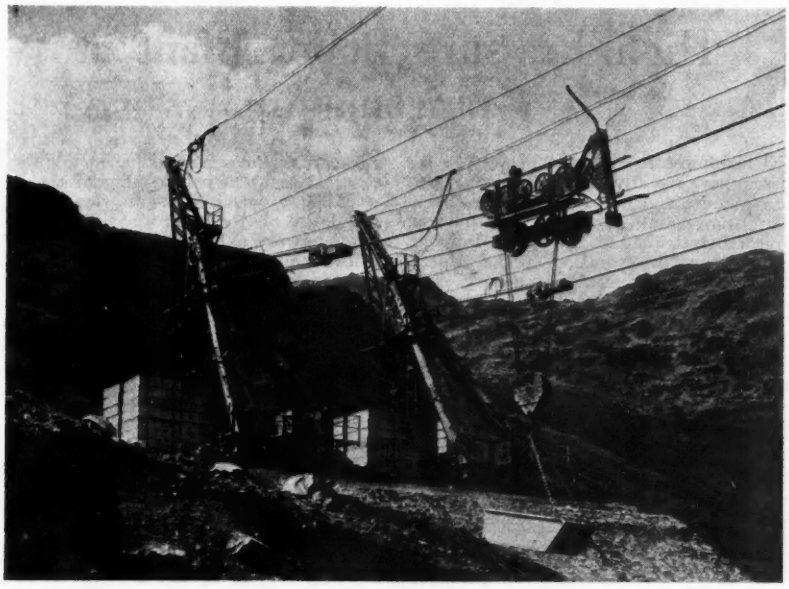


Fig. 19—Cableway Tail Carriages and Load Carriage

The two fixed head masts are 125ft high, and are guyed at back and sides to concrete anchorages; the top of each mast is arranged to swivel to accommodate the movement of the tail carriages. The latter are 36ft in height, and are mounted on four 4-wheeled bogies, travelling on tracks at 25ft centres; both tail carriages travel along the same track. The tail carriages, load carriage and concrete skip may be observed in Fig. 19.

The hoisting and lowering speeds with full load are 250ft per minute and the travelling speed of the load carriage in either direction with full load is 1000ft per minute. The electric motor for operating these motions is 250 b.h.p. on each cableway. The tail carriages travel at 25ft per minute, and are each driven by a 45 b.h.p. motor. The power supply is brought from the temporary station at Inveruglas and is transformed down to 415V for driving the motors.

The winding gears and operators' platforms are enclosed in a steel framed house, the control platform for each machine being placed in an elevated position at the front, to give the operator a good view of the work. The travelling motion of the tail carriages is also controlled from the same platform. All motions are controlled by contactor panels with master control drums, and directions are given by telephone from the concreting site. The hoisting and travelling controls are arranged to give slow speeds by electric control, and the full load can be lowered under control at varying speeds without

recourse to mechanical brakes. Power to the motor in each tail carriage is transmitted by a power cable suspended between the head and tail supports. Limit switches are fitted on the tail carriage to bring these to rest at the ends of the track and to prevent the two carriages fouling each other.

CONTRACTORS FOR THE LOCH SLOY SCHEME

Preliminary Works

Access roads and railway stations and yards: Crowley Russell and Co., Ltd.; A. M. Carmichael, Ltd., and L.N.E.R.
Coiregrogain quarry and conveyor: Keir and Cawder, Ltd., Mavor and Coulson, Ltd., and English Electric Company, Ltd.
Temporary power station: Mirrlees, Bickerton and Day, Crowley Russell and Co., Ltd., Kelvin Construction Company
Temporary transmission lines: Spiers and Co., Ltd.
Pipe-line bridge: Crowley Russell and Co., Ltd.; Sir Wm. Arrol and Co., Ltd., and L.N.E.R.
Cableways: J. M. Henderson and Co., Ltd.

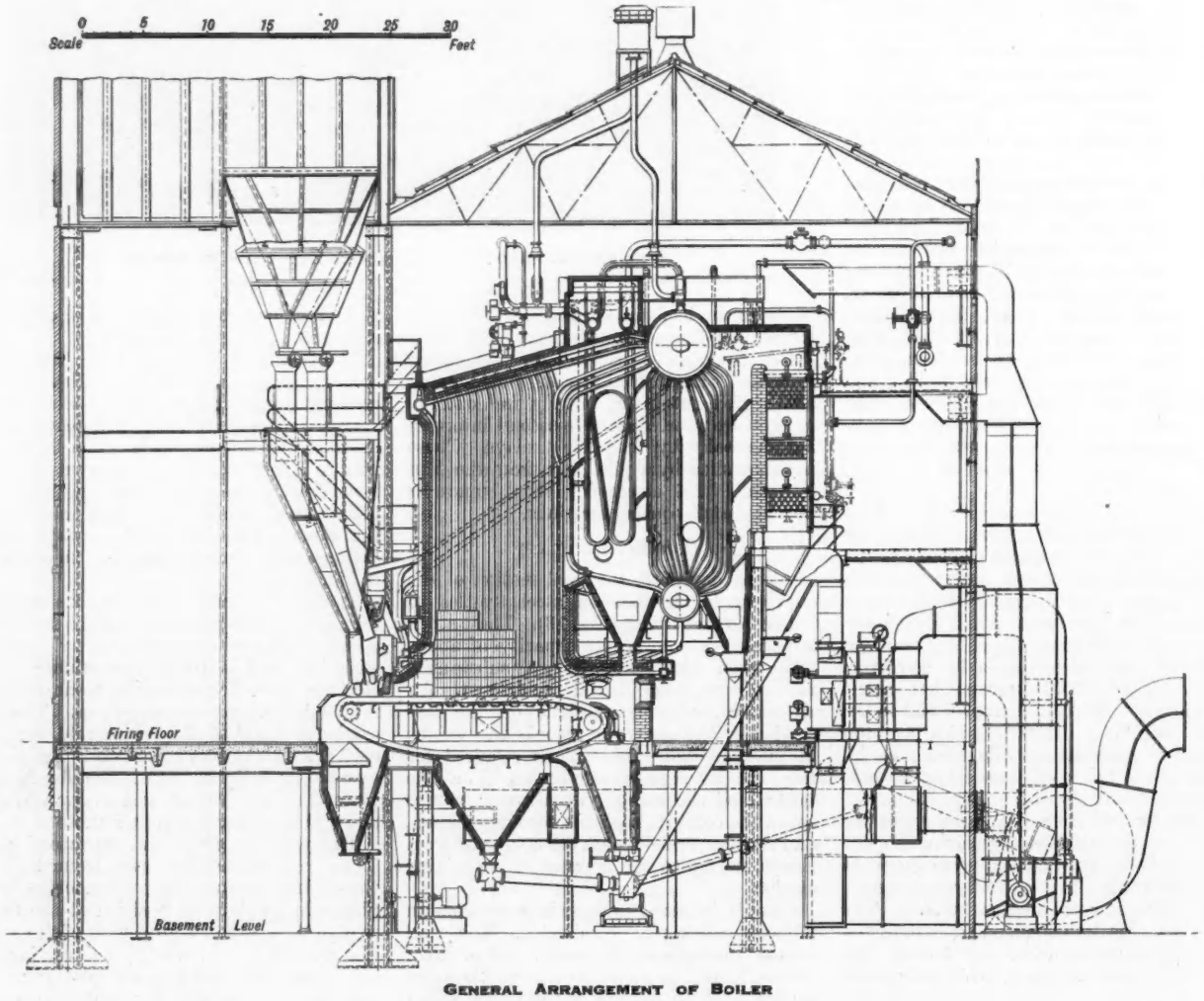
Main Works

Dam: Balfour, Beatty and Co., Ltd.
Main tunnel: Edmund Nuttall, Sons and Co., Ltd.
Pipe-lines: Sir Wm. Arrol and Co., Ltd.
Power station: Hugh Leggatt and Sons, Ltd.
Main valves, sluice gates and screens: Glenfield and Kennedy, Ltd.
Hydraulic and electrical machinery: English Electric Company, Ltd. (sub-contractors for construction of turbines, Harland and Wolff, Ltd.)
Aqueducts: Balfour, Beatty and Co., Ltd., Edmund Nuttall, Sons and Co., Ltd.
Switching station: Hugh Leggatt and Sons, Ltd., Balfour, Beatty and Co., Ltd., English Electric Company, Ltd.
Transmission lines: Balfour, Beatty and Co., Ltd.

High Pressure Boiler Plant at Grangemouth

TWO high-pressure boilers of Foster Wheeler design have recently been built by Richardsons, Westgarth and Co., Ltd., for installation at the Grangemouth works of the Imperial Chemical Industries, Ltd., Dyestuffs Division, and are now in operation. The general arrangement of the plant is shown in our drawing. Complete with all auxiliaries, including coal and ash handling plant, it only occupies part of the site, provision having been made in the lay-out to meet possible future demands for expansion and there is space for an additional five boilers to make an ultimate total of seven units.

Before commencing building, an investigation revealed that the poor quality of the ground would only permit a bearing load on a raft foundation of 10 cwt per square foot, so that it was necessary to pile the site, piles 80ft long, in two lengths of 40ft, being driven. On concrete beams formed across the pile caps a raft of normal reinforced concrete construction was built, upon which was erected a steel framed building having brick panels, except at one side, which was sheeted so as to allow for future extensions. A brick chimney 170ft high serves the two boilers and to the north of the boiler house an annexe has been erected to house the water treatment plant, feed pumps, both of which are illustrated, and deaerators.



GENERAL ARRANGEMENT OF BOILER

DESIGN CONDITIONS

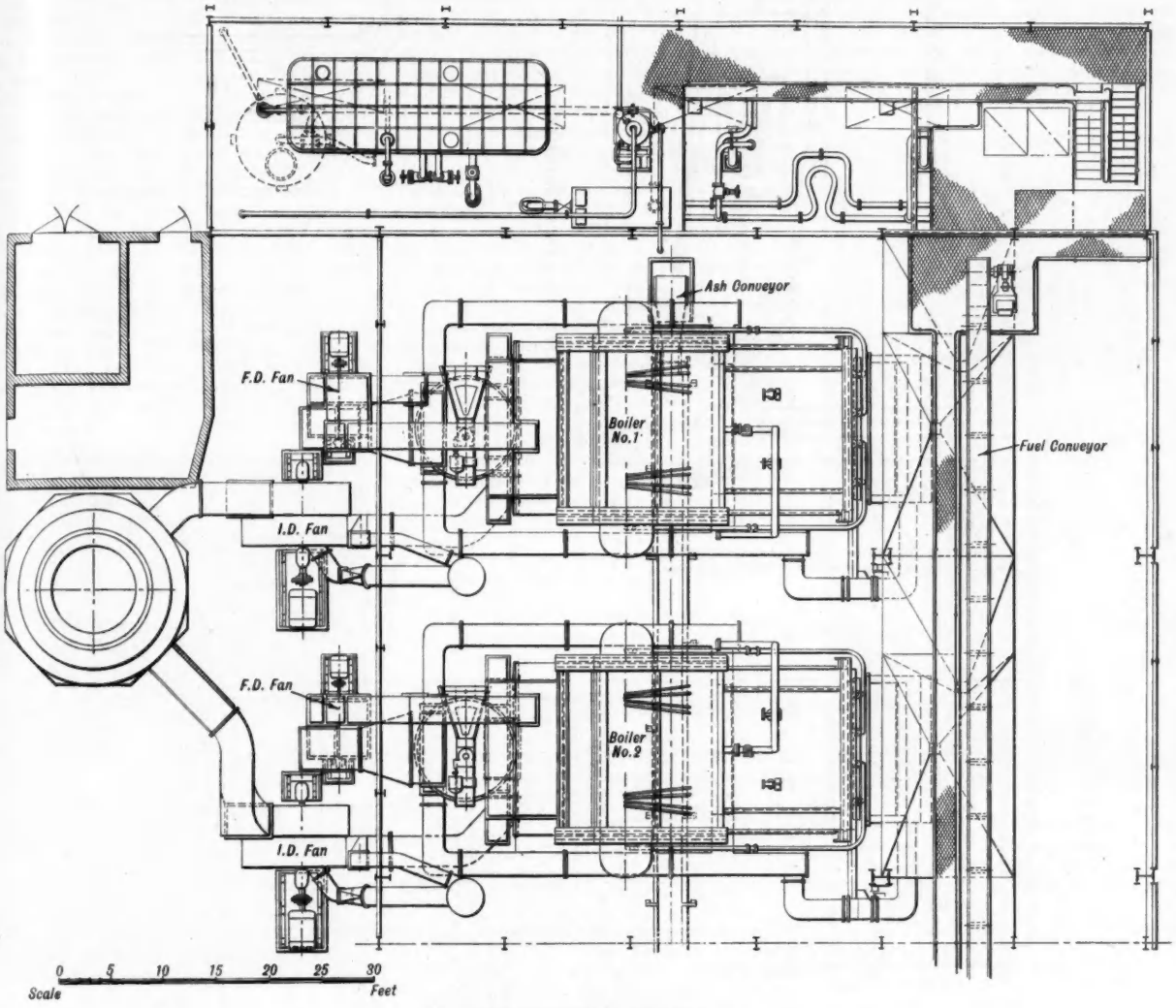
The design specification of each boiler called for a peak evaporation of 56,250 lb per hour with a maximum continuous rating of 45,000 lb per hour and an economical evaporation of 34,000 lb per hour. The boiler is designed for a pressure of 730 lb per square inch and a pressure of 650 lb per square inch at the superheater outlet. When steaming at maximum continuous rating the superheater outlet temperature is 315 deg. Cent., the surface being 722 square feet when supplying steam for process work and using two elements. After the installation of additional turbine plant five heating elements will be used and the outlet temperature will then be raised to 420 deg. Cent. and the surface increased to 2480 square feet. The combustion chamber has a volume of 3342 cubic feet and the grate area is 192 square feet. The boiler heating and water wall surfaces are 6394 square feet and 1465 square feet respectively. An economiser and an air heater are fitted to each boiler. The economiser has a surface area of 2764 square feet the temperature of the feed water being 70 deg. Cent. at entry and 131 deg. Cent. at outlet. The air heater has a surface of 5850 square feet.

GENERAL DESCRIPTION

Our drawing reproduced on this page illustrates the general arrangement of the Foster Wheeler two drum bent tube boiler equipped with a mechanical stoker and operating on a balanced draught system with supplementary over-fire air.

The steam and water drums are connected by vertical banks of 2in outside diameter by

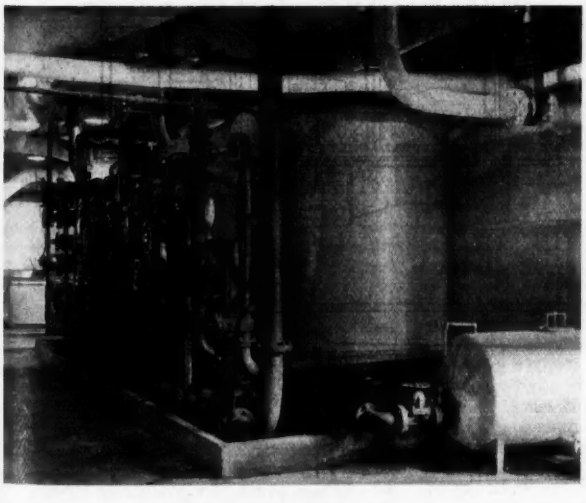
No. 7 gauge tubes which are expanded into them. Arranged in front of the main bank of boiler tubes is the combustion chamber which is water-cooled on the side, front, rear and roof, the water circulation being integral with that which from the water-cooled side walls; tubes bent to form the combustion chamber upper roof, connect the top headers to the steam drum and so complete the circuit. Cast iron "Blizard" blocks, fitted in sections and having the bottom and top headers, which are outside the furnace, form the water-cooled front wall and tubes connecting the upper header and steam drum form the combustion chamber lower roof to complete the circuit. The rear



LAY-OUT OF BOILER PLANT

of the boiler. Tubes connecting the water drum and bottom headers, which are placed with their top surfaces level with the grate, supply the side water walls. The bottom headers are protected from any abrasive action due to fuel spilling over the sides of the grate and are connected to the top headers by riser tubes metallic contact over two-thirds of the tube circumference, protect the lower part of the side wall tubes adjacent to the stoker and present a flat surface to the combustion chamber.

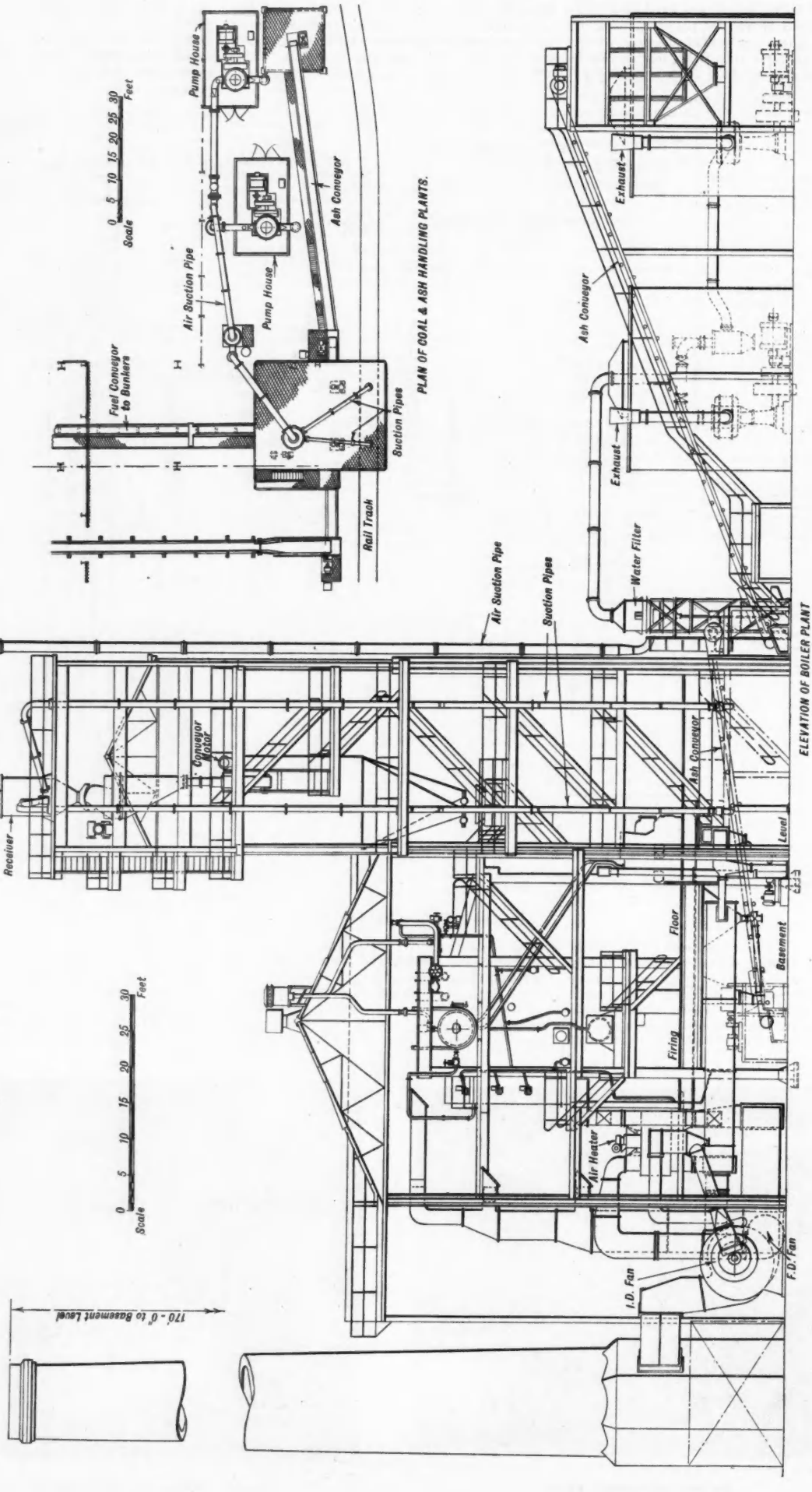
Downcomer tubes connecting the steam and water drum to the lower front header supply the front water wall; riser tubes connecting wall is fed through tubes connecting the water drum and rear header which is linked to the steam drum by riser tubes. The lower portions of these tubes form the water-cooled rear arch and the spacing of the upper portions, where the gases enter the convection bank, is increased by staggering. All water tubes and the two



WATER TREATMENT PLANT

FURNACE FRONTS AND INSTRUMENT PANEL

HIGH PRESSURE BOILER PLANT AT GRANGEMOUTH

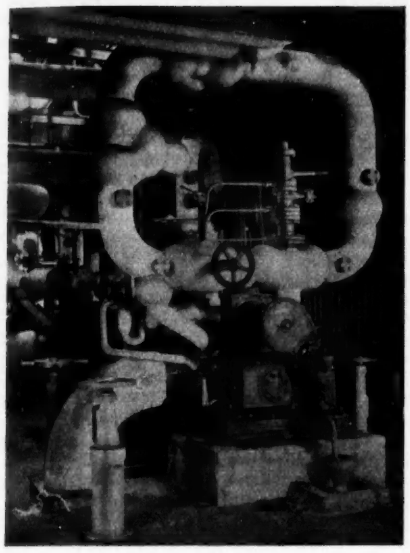


rows of tubes nearest the furnace are 3½in outside diameter by No. 3 gauge.

Steam and water drums are of solid forged steel with integral drum ends and a 16in by 12in hinged manhole door at each end provides means of access. The steam drum is supported by slings which are attached to the main cross members of the steel structure and are provided with rocking washers to allow for longitudinal expansion relative to the boiler framework. The internal fittings consist of Chevron eliminators, Tracy purifiers and perforated feed pipes below the water level. The main bank of tubes carries the water drum which is free to move vertically and to expand longitudinally.

Cope's "Flowmatic" feed regulation is provided and the boiler mountings, including safety valve silencers on the boiler house roof, are supplied by Hopkinsons, Ltd., who also installed electrically-operated soot blowers for the boiler, economiser and air heater. All the instruments and controls are grouped in a panel made by George Kent Ltd, as shown in one of our illustrations.

The make-up feed water is from Grangemouth Town supply which is coagulated, filtered and softened by the base exchange process. A



FEED PUMP ANNEXE

vacuum deaerator removes the dissolved oxygen from the softened water and simultaneously it is heated to 70 deg. Cent. The feed water is continuously treated with caustic soda and sodium sulphite and is finally slug-dosed with sodium phosphate.

REFRACTORIES AND INSULATION

The Detrick uncooled ignition arch is kept as short as possible and the rear arch, already described, is backed by refractory bolted to the arch casing so that the tubes carry no weight. Front and side walls of the combustion chamber are lined with firebrick tiles 3½in thick backed by high and low temperature insulation of 3in and 2½in thickness, respectively the whole being covered by a ½in of hard setting cement wire mesh reinforced, the usual air space being left between insulation and boiler casing. Tie back lugs welded to the tubes and bolted to angles attached to the boiler steelwork support sections of the tiles, allowance being made for differential expansion. The "Blizard" blocks are backed by a plastic refractory 3½in thick, and layers of high and low temperature insulation each 3in thick. Firebrick 3½in thick and layers 3in in thickness of high and low temperature insulation, bolted to the steel casing, line the side walls in way of the main bank of tubes. The insulation of the lower roof consists of 2½in thick firebrick tiles with 4in of high temperature insulation in way of the superheater box. Above the upper roof tubes and attached to the under side of the roof casing is high and low temperature insulation 3in and 2½in thick respectively enclosed by screen plates. Supported on steel girders, 14in firebrick forms a wall between boiler and economiser.

SUPERHEATER AND ECONOMISER

Fitted behind the front two rows of main bank boiler tubes is a "Foster Wheeler" pendent convection pattern superheater. The heating elements, which are free to move under thermal expansion, hang vertically from the headers outside the flow of gases and are slung from the main boiler structure. As arranged at present each element consists of two loops of 2in outside diameter by No. 5 gauge seamless mild steel tube but as already indicated provision has been made to install five loops at a later date. There are two steam passes, the steam enters the outer ends of the combined inlet and outlet header flows through the elements to the intermediate header and returns through another set of loops to the central section of the combined inlet and outlet header. The main steam stop valve and isolating valve, a Flowmatic isolating valve, a pressure gauge isolating valve, the sootblower master valve, and the superheater safety valve and outlet vent valve are mounted on the superheater outlet piping.

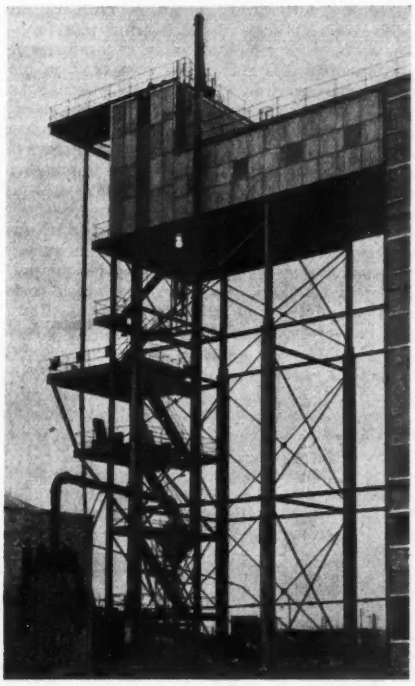
Green's Premier Diamond economiser is fitted; it operates with the gas flowing downward and water flowing upwards with double flow on the water side and has three tiers of gilled tubes. The Howden Ljungstrom air heater is designed for parallel flow of air and gases and is equipped for washing and for element removal while the boiler is on load.

FIRING ARRANGEMENTS

Each boiler is equipped with an International single travelling grate stoker, 12ft wide by 16ft long, driven by a self-contained gear, the power being transmitted through an eight-speed gearbox. The stoker, fed from a divided fuel hopper, can burn coal or coal and coke on the sandwich system with coke breeze up to 25 per cent weight of the total fuel. The fans are manufactured by James Howden and Co., Ltd. The forced draught fan can deliver 22,300 cubic feet per minute at 27 deg. Cent. against a head of 6in w.g., and the induced draught fan has a capacity of 39,200 cubic feet per minute at 151 deg. Cent. the pressure drop being 7in w.g., while the secondary air fan supplies 5850 cubic feet per minute at 120 deg. Cent. against a head of 11in w.g. The inlet vane controls of the forced draught and induced draught fans are operated from the boiler panel by the Lockheed hydro-electric system, while the secondary air fan is damper controlled. Constant speed motors drive the forced draught and secondary air fans and a two-speed motor the induced draught fan. Air from the forced draught fan passes to the control vanes in the air distribution frames via the air-heater and the main dust hopper under the stoker. High-pressure over-fire air reaches the furnace through nozzles placed above the ignition arch and the secondary air fan suction is connected to the front riddlings hopper and the hot air duct.

COAL AND ASH HANDLING

The elevation and plan view of these plants are shown in our drawing reproduced on the opposite page. Manufactured by Simon Handling Engineers, Ltd., the coal handling plant, illustrated in our engraving operates on the pneumatic suction system and consists of two single cylinder vacuum pumps, one working and one standby, each capable of discharging the full capacity of fuel. One of two suction pipes delivers the fuel from wagons at ground level to a receiver placed above bunker level, where the fuel is separated automatically from the air and passes through a tipper discharger into a compensating hopper, and then a chute delivers the fuel to a belt conveyor which distributes it to the various bunkers. Dust is removed from the separated air by a cyclone, having an external rotary seal, fitted inside the receiver. A chute returns the dust back to the main feed. A water filter located at a low level removes any fine dust remaining in the air and deposits it into a sludge tank. The air is drawn along the air suction line to the vacuum pump and discharged to the atmosphere. In addition to the upper bend and rigid piping each suction line has three flexible sections and an electrically-operated telescopic section having a vertical adjustment of 12ft and arranged for remote control by the operator in the wagon. The provision of isolating valves enables either vacuum pump to be rapidly connected to the air suction line. Existing arrangements permit the capacity of



PNEUMATIC COAL HANDLING PLANT

the plant to be doubled against future expansion by fitting an additional receiver, filter and associated piping.

An underground belt conveyor running in a cast iron trough underneath the boilers carries the quenched ash outside the boiler house and deposits it on to an inclined band conveyor discharging on to a second inclined band conveyor which deposits the ash into a granite lined steel overhead storage bunker ready for loading into wagons.

STEAMING TEST

During a test of six hours duration, the rate of evaporation was 48,110 lb per hour with a steam outlet pressure of 654 lb per square inch gauge and a temperature of 370 deg. Cent.; feed inlet at 68 deg. Cent., gas temperature at air heater exit of 138 deg. Cent., the coal used having a calorific value of 10,584 B.Th.U.'s per pound. The gross overall efficiency was 84·91 per cent.

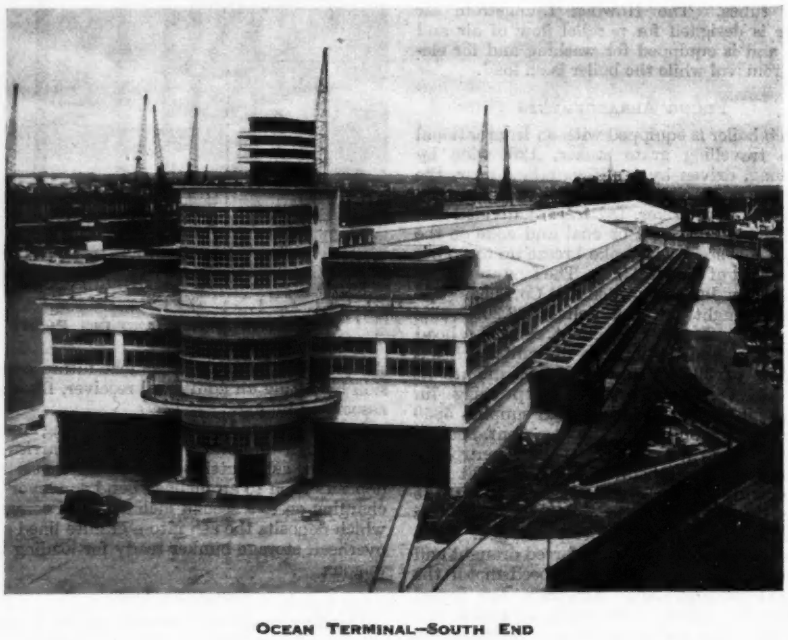
A HISTORY OF RANSOMES AND RAPIER, LTD.—We have received from Ransomes and Rapier, Ltd., a book entitled "Eighty Years of Enterprise," written by Mr. R. Stanley Lewis, a director of the firm. This now well-known firm was founded in 1869 by three partners, Messrs. J. A. and R. J. Ransome and R. C. Rapier. These three gentlemen decided to go into business when the parent firm, Ransomes, Sims and Head, now Ransomes, Sims and Jefferies, decided that its increasing agricultural commitments made it inconvenient to carry on with railway work, bridge construction, &c. From its inception the new firm displayed a particular interest in the development of new and unusual equipment and machines. In this connection, for the early part of his book, the author has drawn upon a fund of amusing and interesting intimate stories relating to the schemes in which the company became involved. After dealing with the early history of the firm the book proceeds to outline in a clear, interesting manner the development of the business and its now well-known range of products, which include sluice gates, excavators, cranes, contractors' plant, &c.

The Ocean Terminal at Southampton

ON Monday, July 31st, the new building, known as the Ocean Terminal, on the quayside of the Ocean Dock at Southampton, was opened by the Prime Minister, Mr. C. R. Attlee. The new building is intended to accommodate the inevitable embarking and disembarking formalities which accompany an ocean voyage, and in discharging this function it sets a very high standard of comfort and convenience. As Mr. Attlee remarked in his speech, delivered on board the "Queen Elizabeth," where the guests attending the ceremony were entertained to lunch, the approaches to this country are generally "somewhat dingy." Thus the important first impression which a visitor receives is likely to be unfavourable. Lord Hurcomb, the chairman of the British Transport Commission, in proposing the toast to "H.M. Ministers," also made reference to this point when he said that facilities had been provided which were equal to, if they did not surpass, those of any port in the world. Visitors to this country need never doubt the welcome that awaited them, he added. In various parts of the world, continued Lord Hurcomb, much attention had been paid to the terminals of airports and it was high time that this country provided at its principal approach for those arriving by sea comparable facilities. Lord Hurcomb also remarked that it followed from the statutory shape of the Commissions' organisation that Southampton Docks would in future be administered by the Docks and Inland Waterways Executive, but he gave an assurance that any administrative dislocation would be avoided.

Mr. Alfred Barnes, Minister of Transport, was also present at the ceremony and proposed the toast to the Cunard Steamship Company, which was responded to by Mr. F. A. Bates, chairman of the Company. Sir Eustace Missenden, chairman of the Railway Executive, Sir Reginald Hill, chairman of the Docks and Inland Waterways Executive, and Sir Eric Gore Browne, former chairman of the Southern Railway Company, were amongst the many guests present at the ceremony.

The Ocean Terminal is a two-storey building in which passengers will disembark directly on to a balcony at first floor level and then pass through large waiting rooms into halls where Customs examination and immigration formalities will be completed. They will then descend by escalators to the ground floor, where the boat trains for London or their cars will be awaiting them. The waiting rooms are situated in the middle of the building and the Customs examination halls at either end. There is also a sightseers' balcony on top of the building.



OCEAN TERMINAL—SOUTH END

Structural Details

The overall length of the building, excluding the semi-circular feature at the south end, is 1272ft 6in, the width over the outside walls is 111ft 6in at ground level and 94ft 6in at first floor level, and the general height from quay level to the main ridge is 53ft 7in.

The Terminal is a steel-framed structure supported on piled foundations, the majority of the piles penetrating about 35ft below ground level, where they rest on a bed of ballast overlying green sand. A certain number of individual piles struck soft spots in the formation and penetrated deeper than this, one reaching to 70ft below ground level. A total of 433 piles of 17½in diameter and 195 piles of 20in diameter were driven for the support of the building and the adjacent transformer house. The piles used were of the type made up from hollow precast sections, filled with in-situ concrete after driving.

The steel framework is disposed in a series of cross-sectional frames spaced at 20ft centres throughout the length of the structure. The ground floor storey is of orthodox beam and column construction. At the centre of the building on the west side (the quay side) a longitudinal plate girder 6ft 3in deep and continuous over three spans, two of 80ft and one of 100ft, carries the external balcony over the scissors crossing, whereby intermediate rail connection is provided between the rail track immediately inside and the tracks outside the building. To allow the necessary clearances the intermediate supporting columns which divide this girder into the spans mentioned above had to be formed of 9in diameter solid steel shafts. Above the first floor level the building is designed as a two-pin continuous portal frame, springing from rocker bearings at first floor level. Each portal has a span of about 90ft, a height of about 16ft to the hip, and a rise from hip to ridge of about 15ft. With the exception of three riveted and bolted site erection joints the portal frames are of continuous welded construction, the ruling section being formed of one 24in by 7½in R.S.J. with the addition of flange plates of varying width and thickness according to the incidence of loading.

The storm water disposal system is wholly concealed from the external view of the building. Much of the wall area is taken up by windows, sliding doors or roller shutters. The balance of the walling is in precast concrete slabs supplied by the Blokcrete Co., Ltd., generally 4in thick, faced with a composition of fine Portland stone aggregate. A large number of special blocks for pilasters, entrance quoins, &c., were required. An inner wall of 4in "Lignacite" building blocks separated by a 2in cavity from the outer skin is secured to the latter at intervals by galvanised steel wall ties.

The upper floors throughout the building are constructed in precast reinforced concrete hollow "Bison" flooring units, supported on shelf angles attached to the webs of the main and secondary R.S.J. floor beams, a method of construction which achieved considerable economy in shuttering and also facilitated a very rapid completion of the first floor, thereby providing a valuable addition to the very restricted working space at an early stage in the job. The pitched roof is covered with asbestos-cement combined sheeting, giving two thicknesses of material with a flat surface to the soffit and a ribbed finish externally. Aluminium glazing bars were used for the long runs of glazing in the roof. The void enclosed between the ceiling and the roof accommodates ducts for an electrically operated system of heating and ventilating provided in the waiting rooms.

On the east side of the ground floor the outermost line of columns runs along the length of a double-sided island platform, capable of accommodating two boat trains simultaneously and constructed of standard railway precast concrete units. In order to minimise the obstruction on the platform arising from the structure of the building itself, the closing of the east wall, when the building is not in use, is effected by thirty-seven roller shutters, each 17ft 2in wide. These shutters (John Booth & Sons (Bolton) Ltd.,) are hand-operated but mobile power units are provided, with flexible driving shafts capable of being clutched into the winding socket of the roller shutters. A separate power plug connection is fitted for each shutter, controlled by push-button starters and limit switches so that overwinding of the shutters by the use of the mobile unit is automatically prevented.

The eastern side of the platform is covered by a reinforced concrete canopy, 1058ft 8in long, projecting 11ft from the side of the building, with 9in diameter glass lenses cast into the 4in thickness of the barrel.

The sightseers' balcony, which is 18ft 6in above the first floor level, is constructed of a 4½in thick reinforced concrete slab supported on three longitudinal reinforced concrete beams spanning between the main frames of the building. One of these beams, along the back edge of the balcony, is formed above and not below the slab, and thus forms the plinth of the parapet wall at the back of the balcony. For some 480ft in the centre of the building the balcony is widened outwards in two successive stages, the extension being carried by reinforced concrete cantilevers anchored back to the parapet beam or to the main steel framework. This widening enables the enclosed sightseers' verandah to be accommodated.

Two expansion joints are provided in the length of the building, one at each of the junctions between the waiting halls and the Customs halls. At each end of these joints the main cross-sectional frame is "afloat" longitudinally, expansion taking place into it from both sides by means of slotted end connections in the floor beams, purlins, &c. Bronze sliding plates cover the joints in the concrete floors and flexible copper strips those in the precast block walls. Aluminium cover plates perform a similar function in the roof glazing.

Access to the upper balcony is by means of an overhead corridor passing through the slope of the roof above the division formed between the first and cabin class waiting halls. On the

east side of the building this corridor connects with a 69ft span post-tensioned prestressed concrete footbridge, which is supported at its outer end on a separate building incorporating access stairs and the transformer house in which is accommodated the main substation equipment supplying power to the building.

Three twin gangway assemblies of an interesting design, which travel on rails on the first floor balcony, are provided on the western side. Each assembly comprises a turret carrying a pair of vertically revolving sponsons to which the gangways are attached through horizontal trunnions. These gangways were described in detail in our issue of July 14th, page 32.

Passenger Conveying Arrangements

Transport of passengers and their baggage between the ground floor and the first floor of the building is facilitated by the provision of up-to-date machinery, comprising passenger escalators, combined goods and passenger lifts and inclined baggage conveyors, conveniently disposed throughout the building.

Four reversible passenger escalators are installed: two on the railway platforms for train passengers, communicating direct with the vestibules of the waiting halls above, and two in positions at the extreme north and south ends of the building respectively, to deal with passengers arriving or departing by motor-cars.

The escalators, manufactured by J. and E. Hall, Ltd., are nominally 3ft wide, with a 30 deg. slope, and are designed for a 17ft vertical rise in the case of the railway platform units and 21ft in the case of the road passenger units. They are intended primarily for passengers with light hand baggage. Threshold lights are provided to illuminate the step comb plates at each end of the escalators.

Each escalator is driven by an orthodox unit comprising a Lancashire Dynamo and Crypto 16 b.h.p. slip-ring motor mounted on a cast bed-plate and direct coupled to a David Brown worm reduction gear. The speed of the escalators and the loading capacity has been arranged to deal with persons at the rate of 4000 per hour without discomfort; while this rate of transportation will never continue for prolonged periods, the arrival of a loaded boat train will result in full capacity being required for short periods and the mechanical design has been arranged accordingly.

The escalators are controlled by Allen West air-break contactor gear, housed in the driving machinery room, suspended by steelwork from the underside of the first floor. Remote operating push-button switches are concealed behind hinged portions of the newel ends of the escalators.

Goods Handling

A series of twenty combined goods and passenger lifts of 30 cwt capacity have been installed. These are of Hammond and Champness, Ltd., manufacture, and are disposed in pairs along the railway platform and the car loading platforms. They communicate between the two floors only and have the same vertical rise as the corresponding escalators. One additional lift is situated at the extreme south end of the building, communicating between ground, first and second floors. This lift works in a separate lift well and is primarily intended for the use of Customs and waterguard staff, and for the transport of baggage to bonded storage in a room provided on second floor level for the purpose.

With the exception of this particular equipment the lifts are two-speed push-button operated installations, running normally at a speed of 120ft per minute, slowing down on approach to the desired landing to 20ft per minute. The normal rated carrying capacity is 30 cwt, with a 10 per cent overload provision. Each lift is driven by a 15 b.h.p. two-speed "super-silent" sleeve-bearing Tandem Bull motor These motors are of special design and comprise both slip-ring and squirrel-cage units built into the same frame and on a common shaft. The squirrel-cage component is designed for a lower synchronous speed and is brought into use automatically to slow down the car prior to stopping at the desired landing. Automatic self-levelling of the car at the landing stops is obtained by the use of "Pliotron" units, as described below.

A complete system of safety devices, operating and interlocking gear has been provided, including efficient safety gear designed to prevent the car from falling should the lifting ropes break or stretch unduly. Each lift car is provided with a full set of operating push-button switches, an alarm switch for calling aid in emergency, by operating an external alarm bell. At each landing entrance there are "car calling" and "gate opening and closing" push-button switches and an illuminated "car coming" indicator, both set flush into a polished steel surround, which in turn will be surmounted by another illuminated sign indicating the identity of the lift. On arrival at a selected landing the car slows down, the "Pliotron" levelling equipment automatically comes into operation and levels the car to a close limit in relation to the nose edge of the landing. The car then comes to rest and both the car gate and the landing doors automatically open to full width.

The "Pliotron" device referred to above consists essentially of an oscillatory circuit with two flat external coils spaced apart and protected by wooden coil holders. Fixed to the lift guide steelwork are a number of flat vertical metal vanes. The metal vanes are so situated that when the lift car approaches the required level they come into position between the two flat coils mounted on the lift. Inductive balance of the circuit is disturbed by the entry of a metal vane in the space between the two flat coils, whereupon oscillation ceases and a larger current passes through the plate circuit passes, sufficient to operate the sensitive relay, the operating coil of which is connected in series with the plate. This relay in turn operates the respective contactors controlling the squirrel-cage component of the main lift motor and stops the lift car at the required level to within very close limits.

Special consideration has been given to the handling of heavy baggage and stowed cargo between the hold of the ship and the Customs examination halls on the first floor. For this purpose a series of four inclined reversible wooden-slat baggage conveyors have been erected in line in the western half of the building, and conveniently spaced so that two of the conveyors communicate between the ground floor and the north, or first-class Customs hall, and two others between ground floor and the south, or cabin class Customs hall. These conveyors, manufactured by Sovex, Ltd., are inclined at an angle of about 30 deg. and run at a speed of 70ft per minute.

Each conveyor driving units consists of a 10 b.h.p. Lancashire Dynamo and Crypto screen-protected squirrel-cage motor coupled to a David Brown "RHU" worm reduction gear through the medium of a flexible coupling and a Vulcan Sinclair hydraulic coupling, which is intended to protect the mechanism and baggage from mechanical damage in the event of jamming. An electromagnetic brake working on one half of the flexible coupling prevents run-back in case of power failure.

Each conveyor is controlled by remote push-button switches operating an Allen West air-break contactor control panel.

Sound Reproduction System

A comprehensive sound reproduction system has been installed, with facilities for relaying either verbal public announcements, radio reception or gramophone records over any desired combination of eight different loud-speaker circuits. The installation embodies "Ardente" equipment and comprises a four-panel main amplifier and control rack in a control room at the south-east corner of the first-class waiting hall. Above this rack is an illuminated mimic diagram, showing each of the eight loud-speaker circuits and indicating by coloured rear lighting which circuits are in use and which of the three functions is being relayed thereon.

In front of the amplifier rack and a few feet away from it is a horseshoe-shaped remote control desk incorporating a main moving-coil microphone, a remote selector switch unit, a motor-driven gramophone turntable, and a desk type telephone connected to the dock automatic telephone system. With this equipment in easy reach the operator can receive his instructions directly or by telephone; he can then choose the service required for any circuit on the selector unit, and can see from the illuminated diagram that the appropriate circuit has been switched as required.

Electrical Supplies

The electrical power and lighting services for the new terminal buildings are supplied from the transformer substation which, as mentioned earlier, forms part of a separate building. The substation is divided into three compartments, housing, respectively, the h.t. switchgear, the transformers and the l.t. switchgear. On the incoming side the 6·6kV three-core cables terminate on the two incoming units of a six-panel switchboard, comprising Allen West 150MVA, hand-operated, oil-immersed circuit breakers. Three of the circuit breakers are connected by outgoing cables to the transformers and the fourth panel is blank, for future use. There are three English Electric transformers (two of 500kVA and one of 250kVA capacity) with space for another 500kVA unit, if required. The secondary winding of each transformer provides a 415V, three-phase, four-wire supply for power and lighting through the medium of the Allen West l.t. switchboard in the adjoining compartment. This equipment takes the form of an eight-unit, fully interlocked, vertically-isolated oil-circuit-breaker switchboard having a rupturing capacity of 25MVA.

The structural design of the Ocean Terminal and supervision of the work were carried out by Mr. J. H. Jellett and his staff of the Southern Region of British Railways, and the general contractors were Staverton Builders, Ltd. In addition to the various contractors mentioned in the text, West's Piling and Construction Company, Ltd., drove the piles; Concrete, Ltd., supplied and laid the precast floors; the Prestressed Concrete Company, Ltd., were responsible for the access bridge; and the steelwork contractors were the Cargo Fleet Iron Company, Ltd. The mechanical gangways were made and installed by Structural and Mechanical Development Engineers, Ltd. The estimated cost of the Ocean Terminal has been given as about £275,000, plus about £122,000 for internal fittings and £30,000 for the mechanical gangways.

Technical Reports

Properties of Slow Electrons in Polar Materials. By H. Fröhlich, H. Pelzer and S. Zienau. The British Electrical and Allied Industries Research Association (Ref. L/T221). Price 6s., postage 3d.—The properties of a slow electron in a polar crystal are investigated, taking into account its interaction with the polarisation produced by itself. Contrary to previous suggestions it is found that this does not lead to self-trapping, but that the electron behaves essentially like a free electron; this is due to the slow variation of the interaction with the velocity. Previous formulæ on the mean free path are modified.

Arcing Characteristics of Fuses with Small Over-Currents. By H. W. Baxter, B.Sc. (Eng.), A.M.I.E.E., and M. T. Cree. The British Electrical and Allied Industries Research Association (Ref. G/T228). Price 7s. 6d., postage 3d.—This is the seventh report in a series dealing with fundamental fuse research, its predecessor being Ref. G/T204. It discusses the question of fuse performance on small over-currents which is a zone of the range in which operation is inherently difficult. A number of conclusions are drawn, supported by references to test results and calculations.

National Building Studies Bulletin, No. 8: Mortar for Brickwork, Block Construction and Masonry. D.S.I.R. London: H.M.S.O. Price 1s.6d.—This bulletin discusses first the properties that are required in a mortar, and then gives recommendations by which these properties can be obtained. The recommendations cover the mix proportions to be employed with different classes of mortar and also the types of mortar that are suitable for use for specific purposes. For convenience of reference by the practical user, the recommendations are brought together in tabular form.

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TRADE UNIONS AND PRODUCTIVITY

SINCE the Anglo-American Council on Productivity began its work, more than two dozen specialist teams, drawn from various industries in this country, have made tours of investigation in the U.S.A. All the teams have included some trade union representatives and the reports so far published have, therefore, given an indication of the influence of American trade unions in the day-to-day activities of the industries which have been examined. Shortly after these specialist team visits started, however, the suggestion was made that useful results might accrue from the sending to the U.S.A. of a team consisting wholly of British trade unionists to study particularly the way in which American unions are co-operating in dealing with productivity problems. The General Council of the Trades Union Congress approved the suggestion, and a team of ten was formed from unions affiliated to the T.U.C. It spent six weeks in America during the autumn of last year and its report has now been published by the T.U.C. That body makes it clear, however, that the report is not one of its "official" documents. The views expressed are the views of the team responsible for its compilation.

Nevertheless, the report is interesting and helpful. There has been little specific information available over here concerning the part taken by American unions in helping to achieve and maintain the high average rates of productivity ruling in American industry. The members of the team readily acknowledged that British trade unionists stood to gain much by a first-hand study of American union practice and policy. The report shows that in several respects American trade union outlook differs considerably from that which has up till now been evident in this country. A general survey of American trade unionism and a description of what the British team found in the U.S.A. therefore naturally occupy many pages of the report. The team noted, for example, "that the absence of any serious opposition to labour saving machinery, and the comparative lack of union restrictive practices, are undoubtedly a major contribution to increasing productivity," Then, it discovered that—unlike many trade unionists here—American unions do not regard profits as "immoral or a social evil, but usually consider high profits to be a sign of efficiency and relatively high output per man-hour." Another aspect of American trade unionism which impressed the British team is the extent to which instruction in time and motion study techniques is given to workshop representatives. For such instruction, the report says, unions in the main provide their own teaching facilities and do not rely on outside authorities. In addition, the team was somewhat surprised to find that in the U.S.A. there is a lack of interest on the part of the unions in formal joint consultative machinery! Most unions, the team suspects, do not expect or want to be consulted about the running of a plant. The job of managing is left to the management. These are some of the discoveries mentioned in the report. They certainly indicate ways in which American and British trade union viewpoints differ. But this trade union team did not set out only to study American trade union practice. It undertook to consider if, or to what extent, similar methods and activities, or modifications of them, could be introduced into British industry by British trade unions. The recommendations with which the report concludes are worthy of close attention. Among them is a suggestion for the establishment, by the larger unions, of production engineering departments, and the training of production engineers for their national and district offices. It is advocated also that unions should seek to increase production efficiency through a greater use of mechanical aids and the application of time and motion study in order to maximise earning opportunities. And, once again, it is stressed in the report that if British trade unionists want the standard of living to rise continually they cannot justify opposition to the installation of new or modernised machinery or the use of redeployment techniques.

For many years past, trade unions in this country have devoted most of their energies to questions relating to wages and working conditions. The operation of the system of collective bargaining which has been built up—and which is so often claimed to be the best in the world—has taken first place in their programme. But, in more recent times, the scope of British trade union policy has had to be extended, partly by the growth of nationalisation, though principally by the pressure of economic events. Many of those responsible for the conduct of trade union affairs are now keenly aware of the need for fuller co-operation between managements and workers if industrial productivity is to be increased and production costs kept at a rational level. The T.U.C. and some of its affiliated unions have not hesitated to emphasise this need, and have stressed trade unionism's responsibilities for educating the "rank and file" in these matters. It is not easy to measure the success which may have been achieved. Much more, certainly, remains to be done. As the team which visited the U.S.A. declares, "the need in industry for decisive trade union action in which unions must accept their responsibilities as well as claim their rights is perfectly clear." When the 1950 Trades Union Congress assembles at Brighton in a few weeks' time, it will be required to discuss resolutions on the subject of increasing productivity. The T.U.C. will not only enhance its prestige, but will perform a useful service to British industry if it can encourage its constituent unions—and their members—to pay heed now to the recommendations resulting from this revealing study of American trade union outlook.

SAFETY IN MINES RESEARCH, 1948

IT is not generally realised that the death-roll in the mines has been halved in the last twenty years. The actual figures for men killed underground are 891 and 434 for 1928 and 1948 respectively. Admittedly, there has been a concurrent reduction in output of 20 per cent, with a like change in the number of men employed; on the other hand, the amount of machinery in use underground has increased several fold, and the use of electricity in proportion. Bearing in mind that over this period the hazards of all kinds might well have been expected to increase owing to the factors mentioned, in addition to increased use of explosives, and mining at greater depths, the actual trend in casualties is not unsatisfactory. The cause of this marked improvement in safety underground must undoubtedly, we think, be attributed to the intensification of research into the whole matter over that period, coupled with the dissemination of the findings through the institutes of mining engineers, technical colleges, and miners' welfare halls, and their application under the supervision of the inspectors of mines. This opinion is supported by reading some of the papers published in the "Transactions" of the Institution of Mining Engineers for 1928 in comparison with those of recent years. The change in tone, in precision of statement as well as in the width of knowledge revealed, is striking and convincing on this point. No inconsiderable contribution has been made by individual mining engineers, colliery managers and firms supplying equipment, but the Safety in Mines Research Board has, of course, played the major part throughout in these researches. The 27th Annual Report on this research, recently published, shows that it was as active as ever in 1948.

It is a significant fact that the research organisation was originally founded in 1908

to study coal dust explosions. Now, forty years later, work on this same problem and the associated subjects of mine gases and dusts, explosives and shotfiring, constitutes the major part of the present researches. The number of deaths from explosions and fires continues to vary enormously from year to year. While the minimum number over a period of years has fallen and reached a new low level of 17 in 1948, yet the figure rises inexplicably every few years to peaks exceeding 100; e.g., it reached 307 in 1934 and 179 in 1947. Each of the peak figures was usually caused by several major explosions in that year, whereas none may have occurred in the intervening years. Such a high degree of variation points to a complexity of factors involved, which may possibly be elucidated to some extent by statistical analysis. At present, waterproofed stone dust scattered in the roads is regarded as the best means of preventing the spread of coal dust explosions. But it cannot be accepted as the final solution because of difficulties of application; and certain shale dusts have even been suspected of contributing to pneumoconiosis. Consolidation of the dust on roads by spraying with wetting solutions is making progress. The possibility of accelerated deterioration of haulage ropes exposed to the spray is under observation. However, prevention being better than cure, greater reduction of dust at the source is obviously desirable, and much has been done to that end, e.g., by spraying and wet cutting. The problem is affected by the introduction of new types of machines for cutting and loading the coal, which may affect the rate and quantity and quality of dust made. To limit the sources of ignition causing explosions, flameproof electric equipment and the "intrinsic safety" of low-power apparatus is insisted upon. These features are being demanded by certain other industries, and the Ministry is the testing authority under a British Standard Specification. A dual risk is involved in shotfiring, one of causing an ignition leading to an explosion, and one of direct injury by the action of the shot—the latter often resulting from sheer carelessness. The practice of shotfiring with delay-action detonators is increasing, and thirty shots in one round are often fired when stone drifting on roads. But it seems unlikely that fifty million shots per annum can be fired entirely without accident.

Serious as are the risks arising from explosions, yet it is falls of ground which account for most deaths underground, averaging about half the total per annum; and haulage accidents, which are next most numerous, account for about one-quarter of the total. In both categories the uniformity arises from the large number of accidents which occur, each involving but one or two killed. Improvements in supports and their use are under constant review, with the aim of affording easier and safer operation and better control of the roof. The hydraulic prop is the outstanding innovation of recent years; one manufacturer had supplied 7000 of these props at the end of the year. They were used in extensive trials in the East Midlands Division with excellent results, and the number in use is increasing. Investigations of light alloy supports were made in co-operation with three manufacturers of aluminium base alloys. Attention was given chiefly to the development of overhead supports, such as roof bars, in which a reduction of weight is particularly advantageous. Antiquated systems of rope haulage are still almost universal and are responsible for many killed and injured. During the year the number of locomotives in use underground increased from 90 to 185, of which 170 were diesel-driven with an average horsepower of 60 per locomotive. Many advantages to safety accrue from this development in haulage and the better roads and tracks it requires. At the same time, every care has to be taken to ensure that the added danger to health from the exhaust gases, which depends on the percentage of CO and NO_2 in the atmosphere, is understood and controlled by adequate ventilation.

Sewage Disposal Scheme for Tel Aviv

THE Government of Israel has approved a scheme for the sewerage and sewage disposal of Tel Aviv, Jaffa and the surrounding region, covering an area of 40 square miles. Design work on the scheme, which, it is estimated, will cost £8,285,000, is to commence immediately. The entire project will be completed within five years and will entail the construction of approximately 32 miles of main sewers up to 6ft 6in diameter, together with a sewage purification works to provide full treatment for a population of 600,000 persons, provision being made for an ultimate population of 1,000,000. The project is likely to involve the export of considerable quantities of British machinery and equipment. The consulting engineers for the scheme are Messrs. G. B. Kershaw and Kaufman. It is believed that this is the first occasion on which British consultants, as against American, have been retained for works of this scale in the new State of Israel.

Literature

SHORT NOTICES

The London Motor-Bus, 1896–1949. By R. W. Kidner. South Godstone, Surrey: The Oakwood Press. Price 4s. 6d.—The author of this short, well-illustrated history has been travelling on London's buses for twenty-two years and here tells a story, principally, of unrestrained competition, paying credit to the many "non-combine" fleets of bus companies, which pioneered many improvements and helped to lay the foundations of to-day's London Transport service. Commencing with the advent of the Radcliff-Ward battery-operated vehicle, the "Lifu" oil-fired steamer and the Straker-built Daimler double-deck petrol bus, the essay goes on to deal with the London General Omnibus Company's petrol-electric vehicles, mentions the introduction of the system of "mass-production" repairs at the L.G.O.C. Chiswick works, and describes the early Leyland covered top six wheelers and the revolutionary "LT" and "ST" models of the A.E.C., which were to carry the brunt of twenty years of peace and war. Apart from engineering developments, the author traces the administrative history of London's bus fleets from single-vehicle beginnings, through an era of rationalisation and mergers to July 1, 1933, when control was taken over by the L.P.T.B. Two appendices list the makes of chassis used and the names of London bus fleets within the period covered by the booklet.

Pump Questions and Answers. By Roy Carter, Igor. J. Karassik and Elliott F. Wright. New York: McGraw-Hill Book Company, Inc. Price 42s. 6d.—This book, as the title states, is written in the form of question and answer, and is concerned with the theory, construction, installation, operation and maintenance of pumps. The principal types of pumps are dealt with, namely, centrifugal, vertical turbine, regenerative, rotary, simplex and duplex direct-acting, and horizontal and vertical power units. Each pump is treated fairly exhaustively, the pump and its component parts are described, its functions given, applications outlined and suitable constructional materials discussed. Numerous pumping systems are analysed, technical terms are fully explained and a wide range of maintenance problems thoroughly probed. Pumping troubles receive special treatment, symptoms and their possible causes are listed and suggestions given for the necessary action to be taken. An entire chapter deals with reciprocating pump liquid valves and a similar amount of space is given to the description of piston and plunger packing and also to the important subject of cushion chambers. The information given in the book is amply supplemented by a large number of drawings of pump parts, graphical data and photographs. The pumping of liquids plays an important part in modern economy, and all engineers will find this book very useful in dealing with their problems, as the method of presentation, question and answer is very direct.

A Code for Sewerage Practice. By L. B. Escritt, A.M.I.C.E., F.I.San E. London: The Contractors Record and Municipal Engineering, Lennox House, Norfolk Street, W.C.2. Price 7s. 6d.—The author is a well-known writer on the subjects of sewerage and sewage disposal, and it is of interest to note the reasons given in his preface for the appearance of this volume. He remarks that a good code can become a serious bar to progress if it is not revised and that there is nothing to prevent inferior codes being issued. Some Government publications which appeared towards the end of, and after, the last war have, in Mr. Escritt's opinion, done a great disservice to sanitation in that they have recommended sub-standard methods, and contained serious errors and misstatements. He has, therefore, prepared the present volume in the belief that a corrective to these publications is opportune. The code is divided into three parts dealing respectively with Sewerage, Drainage and Sewage Disposal.

Textbook of Heating and Ventilating. By T. H. F. Holman, C. Cutler, A. H. Sandy and L. M. Clark. London: George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 15s.—This book was prepared to meet the needs of heating and ventilating operatives who are studying for the intermediate examination of the City and Guilds of London Institute. The operatives' course laid down by the Education Board of the Heating and Ventilating Industry extends over two years of study and covers the subjects of heating, ventilating and related science, workshop processes and practice, and drawing and calculations. Accordingly, this work has been divided into two parts—first and second year course—and covers the syllabus in the subjects mentioned. Whilst a practical approach is followed generally, the scientific principles involved are developed progressively, to enable the operative to interpret intelligently the design of heating and ventilating installations. It is hoped to produce later a corresponding textbook covering the last two years of the course, leading to the final City and Guilds examination.

BOOKS RECEIVED

Stabilitätsprobleme der Elastostatik. By Dr.-Ing. Habil. Alf Pflüger. Berlin: Springer-Verlag, Reichpietschufer, 20. Price Dmk 34·50.

Die Eigenschaften des Betons. By Otto Graf. Berlin: Springer-Verlag, Reichpietschufer, 20. Price Dmk 36.

Factory Canteens. By H. M. Harman. London: Emmott and Co., Ltd., 21, Bedford Street, Strand, W.C.2. Price 2s. 6d.

Neuere Festigkeitsprobleme des Ingenieurs. By K. Marguerre. Berlin: Springer-Verlag, Reichpietschufer, 20. Price Dmk 25·50.

Theory and Practice of Perspective. By W. Abbott. London: Blackie and Son, Ltd., 66, Chandos Place, W.C.2. Price 12s. 6d.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SELF-PHASING OF LOCOMOTIVES AND RECORD RUNS

SIR,—In the June issue of *The Locomotive*, I have read with interest a letter from Mr. L. Derens, of Haarlem, Holland, the well-known locomotive engineer, on the above subject. It reminds me of the runs I took in 1940 on the Beyer-Garratt engines, which were described in THE ENGINEER of Oct. 3, 1941, and I would like to quote both Mr. Derens's letter and my article, because I find not only Mr. Derens on my side, but Monsieur André Chapelon also—to say nothing of Mr. L. Pendred, the former Editor of THE ENGINEER—so I am in good company.

(1) Mr. Derens's letter :—"This much contested subject, which was defended by the present writer in *The Locomotive*, has recently received support from Monsieur André Chapelon of the French Railways, well known by his successful experiments on exhaust working, when reporting on his visit to the United States in 1938, gives a description of his footplate experience on the 4–4–4–4 locomotive of the B. and O.R. This engine is provided with two independent driving units working in simple expansion.

"Monsieur Chapelon describes what is called by him 'synchronisation of the exhaust of both cylinder groups' in the following terms: When the engine backs down to the train the exhaust beats of the four cylinders are in irregular succession. But as soon as the locomotive starts with its train the exhaust beats very soon become synchronised, and it seems as if both driving groups were connected through coupling rods. This remarkable phenomena is also found on simple 'Mallet' locomotives and even on the Belgian 'Franco' locomotive, which is the more remarkable since this engine has four independent driving units, each two of them exhausting through separate chimneys. The explanation . . . appears to be . . . that each group slips until the co-operation of both driving units has established the most favourable and uniform drawbar pull . . . Mr. Webb himself held the same view (re the automatic crank adjustment of the 3-cylinder com pounds)."

(2) "A Beyer-Garratt Experience." "I noticed too that the exhaust sounded as though the two units tended to keep together, in step, instead of 'all over the place,' which one would think most likely. For some reason I cannot explain, the two pairs of cylinders persistently exhausted together—there seemed to be only two cylinders in operation. (With reference to this, the Editor writes: 'This is one point that interested me very greatly, as I had observed it myself on one occasion many years ago when Dugald Drummond produced his engine with two pairs of cylinders driving separate axles without coupling rods. He took me for a run on the footplate, and it was noticeable that the engines seemed to keep in beat as the separate engines of the 'Garratt' do. It is by no means easy to suggest a reason why they should do so.') Quoting this has induced cogitation. The only factor that affects both sets of cylinders is the blast pipe . . . . it would be better if the engines did not keep in step, both as regards blast and torque . . . . On the rising gradient to Saxby, wishing to discover whether the two engine units really did get into step, or if it were only my ears playing tricks, I rode awhile on the platform in front of the smokebox to settle the matter. It was even so—synchronisation apparently did tend to take place."

A correspondent, Mr. Pickett of Bedford, residing within 2 miles of the main line, stated that from his frequent observations I was in error. Other correspondents took my point of view. Reading Mr. Pickett's letter again, I notice that his statement is chiefly to the effect that the Garratts have their cranks at "any old angle" when stopped. This rather lets me out—and Mr. Derens, Monsieur Chapelon and presumably Mr. Webb. Our observations—at any rate, certainly mine—were made under running conditions; that is when the two engines seem to synchronise. So, with all this evidence to back up my admittedly not very extensive observations, I feel justified in holding to my original opinion.

Something on another subject—high speed. A little while ago there was correspondence in THE ENGINEER about one of these unauthenticated American "records"—their name is legion—stated to have been achieved by a Pennsylvania Railway "Atlantic"; 127 m.p.h., I think was the figure, and it was asked if there were any evidence to substantiate it. Personally, I do not suppose there is, or that the run was ever done, any more than that fantastic 112 m.p.h. was ever reached by No. 999. Unless I am much mistaken, on doubts being expressed as to the validity of this record, another run was made to clinch the nail, and the maximum speed attained was in the neighbourhood of 90 m.p.h., a much more reasonable and likely figure. A locomotive with Stephenson valve-gear—No. 999 had this—would be most unlikely to approach any such velocity. Yet that silly yarn still goes the rounds among the credulous. Why bother about them? Surely Americans have always been notorious for claiming "records" in every imaginable field, often with no justification. A few years ago the *Railroad Magazine* had a story that for pure inanity beat anything I ever read. A mail train stalled with engine trouble; there happened to be a freight train on a nearby siding; the engine was commandeered (4–6–0 with 57in drivers, No. 111—these flyers are always numbered in the 3s!); the mail train made up all the lost time, pulling triumphantly into Oshkosh, Kalamazoo, Devil's Gulch or some such place dead on time, having averaged exactly 120 m.p.h.! Not 119·9 m.p.h., be it noted, or 121·1 m.p.h.—exactly 120 m.p.h. Kolossal!! It was too much for me. I wrote to the Editor, inquiring how, as a presumably responsible man, he allowed such drivel to be injected into his columns, to be ultimately informed, after much hesitation, that the story was intended to be regarded as a legend only! On my returning to the attack with the rejoinder that the story did not read that way at all, but was clearly meant to be believed, in the next number of the magazine it was stated that inquiries had been made into the "record," and it could be accepted as duly having been made, *because* (my italics) an official of the company was in the cab, and he *said* it was done, so that was that. It was probably the chief of the dining-car department, and after lunch. This "record," by the way, was made about fifty years ago; No. 999's was in 1890-something. But for a perfect example of this American habit of claiming to excel in everything, nothing could well beat the calm assertion made in the Preface of a monumental tome on the locomotive published a few years ago—in the '40s—in the States, the author being the Chief Engineer of the Baldwin Locomotive Co.—I forget his name at the moment—which naturally excuses the uninformed for accepting it as authoritative. The statement was that "all locomotive records without exception have been made in America!" I will not assert categorically that this is an exact quotation, but I think it is—at any rate, that is the sense of it.

But we British should not be too critical, perhaps, at these transatlantic flights of fancy. Did we not claim for many, many years that the G.W.R. "City of Truro" had reached 104 m.p.h.? Was she not put into York Museum on the strength of it? And was not the bottom knocked clean out of the claim a few years ago, and the thing proved to have been impossible! Somebody please correct me if I am wrong. After all, most of these "maximum" speeds have been done downhill, which to my mind reduces their value considerably. What is the maximum "on the level"? Is this not still the 132 m.p.h. reached in 1902 by the Siemens or A.E.G. electric experimental machine between Berlin and Zossen? Why the Americans interest themselves in these silly so-called "records" I cannot understand, when the actual work done on their railways, by both steam and diesel engines is so fine, exceeding anything approached anywhere else in the world, probably. The facts should satisfy them, without straying into fiction: 136,000 miles per day at an average speed of 60 m.p.h. or over; 53,000 at 65 m.p.h. or over; 15,000 at 70 m.p.h. or over; 3000 at 75 m.p.h. or over; 58 miles in 41 min, 85 m.p.h., and scores of other superfast runs. Britain, through no fault of hers—geography, traffic density, the war and its aftermath, &c.—is not in the running at all now, and left far behind. It is sad to admit, but there it is.

EDWARD H. LIVESAY

Victoria, B.C., July 27th.

RUBBER ROADS

SIR,—In THE ENGINEER of May 5th, you published some very interesting particulars of a rubberised road trial that was carried out in April last, and this work should, I think, prove of much benefit to the road user and all concerned.

May I be permitted to draw attention to the fact that rubber-asphalt roads—constructed with rubber powder—were laid in London fourteen years ago, and road surfacing of this kind can be seen to-day in as good condition as when put down, nothing whatever having been spent on work in the way of repair or maintenance during the whole period. I would mention that the process is a permanent hot-laid surfacing, and not a carpet, but at the same time it is suitable for either or any bituminous work.

A. E. H. DUSSEK

Bromley, Kent, July 22nd.

[Mr. Dussek, in support of his remarks, enclosed reprints of articles and photographs describing the laying of the rubber-asphalt road when it was carried out.—ED., THE E.]

THE ANGLO-AMERICAN PRODUCTIVITY COUNCIL: BRITISH DEEP DRAWN METALS PRESSING INDUSTRY REPORT

SIR,—The report and recommendations of the productivity team from the British Deep Drawn Metals Pressing Industry has now been published and is before the industry. I am sure that the importance and value of the report will be recognised by everyone, and I trust that its recommendations will receive serious and immediate consideration.

There is one recommendation on which, with your permission, I would like to add a little note. Among the findings was one which emphasised the urgent need for an association of firms in the British pressed metal industry for the interchange of ideas and for research into problems affecting pressing techniques and production methods.

There is already in existence the Sheet and Strip Metal Users' Technical Association, an organisation which is capable of expansion in the directions that the team would desire, and a most important contribution would be made to fulfilling the whole purpose of the report if that Association took the recommendation into favourable consideration.

J. M. PHILLIPS
(Leader of the Pressed Metal Industry Team)

Coventry, July 27th.

Engineering Education Viewed from Overseas

By An Overseas Professor of Engineering

OVERSEAS students of current discussions on the education of engineers may have been prompted to ask themselves various questions, to which they may or may not have been able to find answers. First of all, why have the arguments broken out again just now? We look in vain for guidance to the announcements of the Joint Engineering Conference, which is to be held next year as part of the Festival of Britain celebrations. There is little sign of doubt or waning confidence here: the effective words are: "... development of the system of education of engineers in Great Britain, which, by the achievements of British engineers, has shown itself to be pre-eminently suited to the conditions in this country." The next question is, why should British engineers require so distinctive a training? Why is it necessary to set aside so resolutely the experience of the great European technological institutions at Zurich, Paris, Karlsruhe or Charlottenburg, or of the American ones in Massachusetts or California? If the Commonwealth of Australia has also found it desirable to develop a great new training centre on these lines, must Great Britain still stand fast?

A plausible reply to queries of that sort might be embodied in the words: British obstinacy. We proffer this suggestion in no censorious spirit, for we who live abroad have learned to be indulgent towards this particular manifestation of the British character; we acknowledge with gratitude that if the British had not been so stubborn in resisting—shall we say, the twenty-four-hour clock—they would not have been so stubborn in resisting Hitler. But we cannot help noticing that when military discipline at last forces the twenty-four-hour clock upon the reluctant British soldier, he is determined to get it wrong, insisting upon translating 1600 hours as "sixteen-hundred hours." Is it strange then that the recent correspondence on engineering education in *The Times* should have brought to mind faint suggestions of the controversial methods of mediæval schoolmen? It is hardly the way of engineers to spend so much time in argument and so little in practical experiment; it was not in that way that the first "Mauretania" was afloat only ten years after the "Turbinia" had astonished the spectators at Spithead. Turbines were put into ships and tried, not just argued about.

Is there not, too, a note of not quite bygone reactionary obstructiveness in this insistence on exclusively university training for engineers? And if the problem is so urgent that one need not scruple to bring in personalities, does university education emerge very creditably? If only residence at a university can give the breadth of experience that fits an engineer to hold high office, where in fact do we find these university-trained engineers in positions of eminence? On the contrary, it is the men with the narrowest specialised professional training who seem to rise highest. The office of Governor-General of New Zealand, for example, has been filled in turn by an admiral, Lord Jellicoe; an air marshal, Sir Cyril Newall, and a Lieutenant-General, Sir Bernard Freyberg; nor can it be said that such appointments are reserved for the Services, for the corresponding position of Governor-General of Canada has been occupied by a professional writer, Lord Tweedsmuir. More significant still, the present Rector of the Imperial College of Science and Technology, Sir Roderic Hill, had previously achieved high professional distinction in the service of the Royal Air Force. What engineers have held the Rectorship or equivalent rank in any British university? Other cultural organisations seem to prefer professionally-trained fighting men at their head, too: Ashridge had General Sir Bernard Paget, and the British Council had General Sir Ronald Adam. Evidence of this sort does suggest that consorting with Arts undergraduates during one's years of training is not the only way of acquiring a broad view of the world and its problems.

How does the universities' claim to monopolise British engineering education harmonise with the belief that it is its freedom, variety and breadth which together form the glory of the British educational system? There is a highly restrictive flavour about the claim. The engineers must come to us, say the universities, but we don't want too many of them lest they should disturb the balance of our traditions: we mustn't let the technicians swamp our culture. Yet, they continue, the engineers must not be allowed to have an educational organisation of their own. Now in what other way can the rapidly-increasing range of engineering practice be taken into account? Should there not be an equivalent extension in the range of institutions that train engineers? It would not excessively widen the range if one—only one—first-class new technological institute were added by way of experiment to the dozen or more British universities. If the training, either at undergraduate or post-graduate level, was inspired by the determination to develop the best possible engineers, they would be very good men of the world too. At any rate, before very long they would have the chance of showing whether they were of a higher or a lower calibre than their confreres from the universities, and thereby of convincing their seniors, who instinctively rely upon the results of comparative practical trials.

The long-range view of the resident in foreign countries may not have any particular penetrating power in these matters, yet we are not wholly aloof from them. Many of the students whom we ourselves try to educate thereafter proceed to Great Britain for higher training; on their return we do not fail to observe how different types of engineering courses have influenced them. Our opinions on this head might not be without value. If the discussion could descend to a commercial level we might have still more to say. We know how high and how skilfully-fostered is the reputation the great Continental technical high schools enjoy abroad, and we have seen how frequently valuable contracts have gone to the firms whose staffs have been trained at these institutions.

Whether or not we expatriate professors unduly flatter ourselves in imagining we can usefully participate in this discussion, at least we are on safe ground in believing that we have a great deal to learn from it. Withdrawn as we are from our opposite numbers at home, who knows what backwaters of instructional technique we may have drifted into? During and before the Festival of Britain Conference next year, we therefore look forward to receiving clear and specific guidance. Just as we do not expect our students to assimilate what may be the cloudy rhetoric of our lectures without requiring them to work out the numerical examples into which their knowledge can be distilled, so now we look to our own mentors to offer or to elicit some final unambiguous expression of what they propose. Would they oblige, for instance, by drawing up a detailed syllabus for an ideal three-year course in engineering at the Faculty of Technology of Red Brick University? How many hours' mathematics in the first year? How many hours in the drawing class in the third year? If they replied that this was the sort of "factual information" that all true educationists should shun, we should suspect that we were dealing with educational doctrinaires and that before long we should be told that the worst crime a teacher can commit is to teach anybody anything.

Another instructive exercise might be this: to choose a few advertisements from THE ENGINEER and then to draw up the precise schemes of training which would best fit applicants for the selected posts. Here are two: "——— and Co., Ltd., invite applications for Works Manager from engineers with good technical qualifications, ... capable of initiating and developing production research in works employing 5500 ..." "Applications will be received ... for three posts of Senior Construction Engineers, Irrigation Department ... The salary attached to the post is £1750 per annum ..." Such exercises would at least ensure that the current needs of the engineering profession were kept under review, even if they left unresolved the problem of how these particular applicants were to know, twenty or thirty years back, that they should direct their training with just such positions in view.

South African Industrial Developments

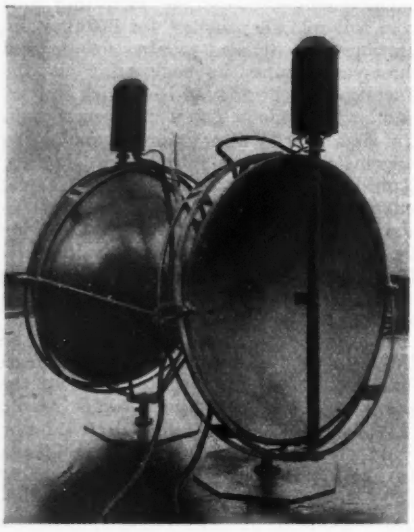
SCAW METALS, Ltd., Transvaal, has drawn up an ambitious development programme for completion in 1950. Its largest project will be a new steel foundry for the production of steel alloy castings including stainless and heat-resisting castings. This foundry will be equipped with a Birlec arc furnace, a high-frequency furnace, and the most modern sand-handling plant. Malleable castings will also be produced in the near future as soon as the electric furnaces, ordered from overseas, are received. An increase in steel ball production will also result from the new National ball-forging machine which is capable of producing 2in diameter balls and smaller at the rate of seventy per minute.

A. C. Wickman (S.A.) (Pty.), Ltd., is erecting a new factory in Brakpan, Transvaal, for the manufacture of production machinery, tungsten carbide tools and drills.

The Henschel Locomotive Works of Kassel, Germany, has completed negotiations for the opening of a new branch factory in South Africa. This factory will probably be built near Springs, Transvaal, before the end of this year. Local workers will be trained by German technicians from the parent factory and for the first eighteen months the South African plant will be used for the assembly of parts imported from Germany. It has been stated that all types of diesel, steam and electric locomotives will be manufactured in the factory.

A Portable Micro-Wave Television Radio Link

FOR linking television transmitters with studios and "outside broadcast" sites, circuits, capable of transmitting the necessary wide band of frequencies, can be provided by coaxial cables, radio links or a combination of both systems. Where mobility is a paramount consideration, a radio link may be the only means of connection to the nearest point of a suitable cable.



RECEIVER AND TRANSMITTER PARABOLOIDS

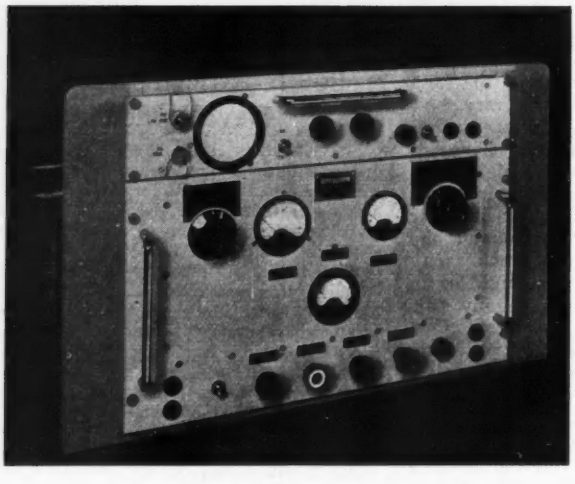
To meet these requirements, Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2, has developed equipment which, after completing satisfactory service trials with the B.B.C., has been used for outside broadcasts including the televising of the University Boat-Race earlier this year.

The company's portable micro-wave television link is essentially a frequency-modulator s.h.f. (super high frequency) system employing carriers of the order of 4000 Mc/s and operating between points within visual range of each other and not more than about 30 miles apart. For transmissions over longer distances, one or more repeaters may be used. These repeaters comprise, without modification, a standard receiver for demodulating incoming signals and a transmitter for remodulating the resulting video signals and passing them on in the desired direction at a frequency shifted from that of the previous link by 40 Mc/s to prevent mutual interference.

As illustrated herewith, the complete mains-operated transmitters and receivers are transportable, being broken down into a number of portable units. Except in the case of permanent receiving terminals, equipment is designed for use in a motor van. The 4ft paraboloid transmitter and/or receiver assembly may be mounted on a spigot on the roof, so that no equipment need be removed from the van for short and unobstructed radio linkages. Where transmission paths are not clear of buildings and leafy trees, it is necessary to find a more elevated or suitable vantage point for the paraboloids.

The function of modulation and demodulation is carried out in the weather-proof canisters immediately above the paraboloids, as illustrated. From here a 2in by 0·667in waveguide is led down to the electro-magnetic horn at the focal point of each paraboloid. This arrangement makes possible the interconnection by coaxial cable of the aerial assemblies with the other units, which make up the complete transmitter and receiver. Since this cable is only called on to carry the intermediate frequency, with subsidiary cables for power feeds, it may be as long as is necessary in any particular circumstances.

Associated with the transmitter unit in its canister above the paraboloid is a separate transmitter control unit (illustrated herewith), which is normally in the van; it includes a cathode ray oscillograph monitor and a power unit. The transmitter unit accepts a 1V (peak-to-peak) video signal into 75 ohms brought up from the transmitter control unit through the length of coaxial cable. This signal is first amplified through a two-stage amplifier and then applied to the modulator electrode of a "coaxial line" s.h.f. oscillator, which is a velocity modulated valve. It is tunable to approximately the desired transmitter frequency by the piston of a calibrated cavity resonator, which provides a range of 100 Mc/s.

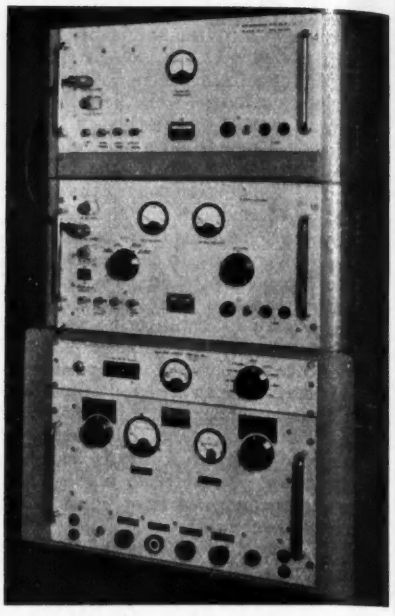


TRANSMITTER CONTROL UNIT

Fine adjustment of the frequency is achieved by varying the mean resonator potential. A small portion of the 300 milliwatts of the radiated power is abstracted and detected on a silicon crystal. The output from this crystal is amplified through a two-stage amplifier and led back by coaxial cable to the monitor unit to furnish a measure of the radiated power. The deviation of the modulator can be chosen to be 2, 4, 6 or 8 Mc/s over a bandwidth of 15 Mc/s.

The receiver unit, mounted in the canister above the receiver aerial, contains a local oscillator of the "coaxial line" type, operating, like the transmitter, on a maximum voltage of 250V. The output is mixed with the incoming signal at a crystal mixer to give the intermediate frequency. This is amplified in a three-stage pre-amplifier, using a grounded-grid triode, and is then led away through the coaxial cable to the associated receiver units, which are illustrated herewith; they comprise a seven-stage intermediate-frequency amplifier unit, a discriminator unit and a power unit.

The seven-stage i.f. amplifier employs staggered tuning, giving a gain of 65 db over a 14 Mc/s band-width. From it the discriminator receives about 1V of i.f., which is first amplitude-limited and then discriminated in the conventional manner. After amplification the video output is fed through a cathode follower to the output jack, where it appears as 1V into 75 ohms. In the discriminator unit, positive-going and negative-going video signals can be selected by push-button irrespective of the sense of the i.f. deviation. A video gain control is provided and a meter on the unit indicates the mean i.f. frequency, so that, knowing the magnitude and sense of deviation, the receiver may be set up to give the correct discriminator excursion.



RECEIVER DISCRIMINATOR, I.F. AMPLIFIER AND POWER UNIT

The power unit is similar to that for the transmitter and supplies the local oscillator through the connecting cable to the aerial canister. The i.f. and discriminator have self-contained power supplies and that of the i.f. unit also supplies the small pre-amplifier through the connecting cable. A meter panel is provided, which may be jacked-in to other units for fault-locating. This panel is additional to the meters used for the setting-up of the equipment, which are built into individual units.

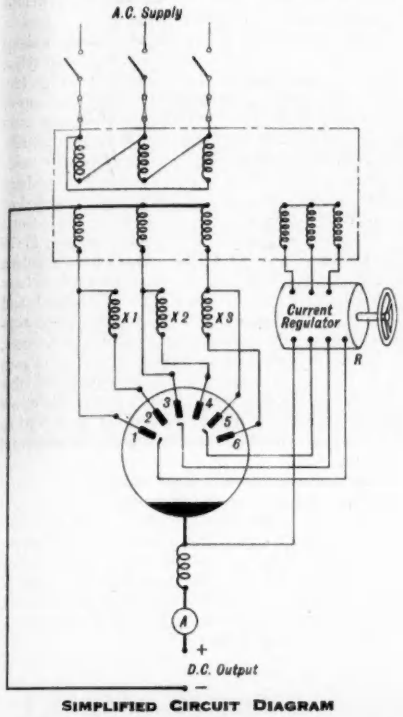
When setting-up the equipment, the oscillators are first set to their nominal frequencies by means of the tunable cavities, that of the receiver being finally adjusted by altering the resonator potential of the local oscillator to give maximum received signal. The paraboloids are set with the aid of a map reading and a hand bearing compass, but slight horizontal panning, together with an adjustment of the elevation of the dishes, may be required for optimum results. After a brief warming-up period, the frequencies will remain sufficiently stable during any individual broadcast. Any change of frequency can be observed on the meter, which indicates the crystal current of the receiving mixer. Minor frequency changes can be corrected by the fine adjustment already described. These adjustments, when necessary, may even be made during transmission.

INSTITUTION OF PRODUCTION ENGINEERS.—The Institution of Production Engineers has announced that the September issue of its Journal has been specially prepared for the benefit of young engineers, and is to be devoted to the educational aspects of production engineering. It is felt that this issue should be of particular interest to students about to enrol for courses in technical colleges, and to college lecturers, careers masters and training officers in industry.

Rectifier Equipment for D.C. Arc Welding

WE have received some particulars of an interesting welding rectifier equipment which, it is claimed, combines the simplicity of a.c. welding plant with the advantages of the d.c. arc for certain classes of work. The new equipment, which has been developed by Hackbridge and Hewittic Electric Company, Ltd., Walton on Thames, Surrey, is based on the company's well-known glass bulb mercury arc rectifier and is a piece of static apparatus.

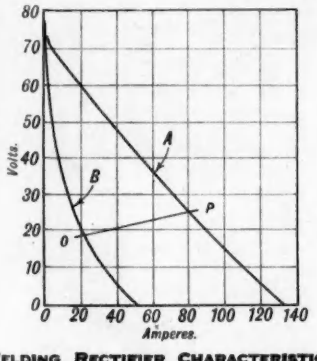
Our illustrations show the welding unit in use and the principle upon which it operates.



SIMPLIFIED CIRCUIT DIAGRAM

Current variation is carried out by a new method using a simple circuit, the essentials of which are reproduced in the accompanying diagram.

A six arm mercury arc rectifier bulb with grid control is so connected that three of the anodes (1, 3, 5) are fed directly from the secondary of an air-cooled transformer and the other



WELDING RECTIFIER CHARACTERISTIC CURVES

three anodes (2, 4, 6) through additional reactances X_1, X_2, X_3. Only the grids associated with the former three anodes are utilised for grid control, these three grids being connected to a simple phase shifting device *R*.

By turning the handwheel of this phase shifter the instant of "firing" of anodes 1, 3, and 5, in each cycle of applied anode voltage, may be advanced or retarded, thereby smoothly varying the average current carried by anode arms 1, 3 and 5. As the "firing" of the anodes is retarded, these arms will carry progressively less, and arms 2, 4 and 6 progressively more of the total rectifier output; conversely, as the "firing" of the anodes is advanced, an increasing fraction of the current will be carried by the arms 2, 4 and 6.

The reactance of the transformer, the secondary of which is connected directly to anodes 1, 3 and 5, is so designed as to provide the characteristic *A* illustrated herewith; and the combined reactance of the transformer and additional reactances X_1, X_2, X_3, in circuit with anodes 2, 4 and 6 give the characteristic *B* in the same illustration. Merely by moving the single handwheel of the phase shifter therefore, completely smooth variation of welding current may be obtained, with an infinite variety of settings between the pre-set characteristics *A* and *B*.

Referring to the same characteristic curves for normal welding voltages, a typical range of current adjustment is shown by the operating line *OP*, i.e., from 20A at 19V, to 80A at 25V, between which limits any setting is instantly available by one hand control.

It is clear from the curves that the open circuit voltage of the rectifier is constant at approximately 80V. The regulation curves have a slope ideally suited to arc welding and cut the normal operating line *OP* at a wide angle, indicating that the incremental regulation remains high at any operating point, ensuring high stability of arc conditions over the whole working range.

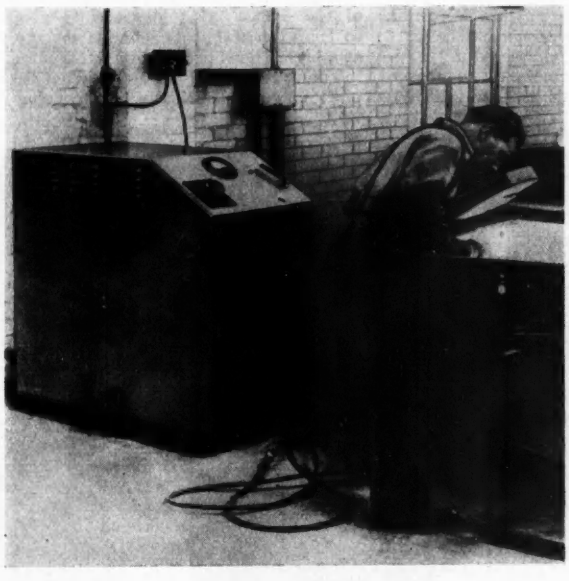
The equipment is so designed that neither pole of the d.c. output is connected to earth. Hence, the polarity of the electrode relative to the work can be made either positive or negative, the changeover being facilitated by a simple link arrangement at the rectifier. The polarity of the electrode is important for certain classes of work and with some types of electrodes. The ease with which the required polarity can be established is, therefore, a useful feature of the Hewittic welding rectifier, increasing its versatility for general welding service.

Unlike rotating plant, the Hewittic welding rectifier has no mechanical or magnetic inertia, so that arc current and voltage follow instantaneously any change in arc condition and length, from short circuit to broken arc, a property which permits a closer control of the welding operation and greater uniformity of work.

The welding unit is simple to operate. As illustrated herewith, it consists, from the operator's viewpoint, of a steel cubicle having, externally, an "on/off" switch, the handwheel of the welding current regulator, an ammeter indicating welding current, and terminals for the connection of the output cable.

The Hewittic welding rectifier is a single operator equipment, and can be supplied for stationary installation or as a mobile unit with wheeled chassis and drawbar.

It can be arranged to operate from any 3-phase a.c. mains system; the standard equipment is suitable for a 50 c/s supply over a range of 360V to 440V, adjustment to match the supply voltage being effected by a simple link arrangement inside the cubicle.



RECTIFIER WELDING PLANT IN USE

Post Office Telephones: Supply, Demand and Shared Service

ALTHOUGH the Post Office has made full use of its restricted resources in manpower and materials to meet the demand for telephone service and although the rate of installation has been considerably higher than the pre-war rate, it has been insufficient to meet the greatly increased demand for service as shown by the following figures.

Year	New Telephones installed	Waiting List at end of year
1936	390,300	900
1937	400,600	6100
1938	279,500	4100
1945	389,600	300,000
1946	697,600	350,300
1947	626,000	467,700
1948	560,900	520,000
1949	528,500	548,500

The number of applicants who must be kept waiting for telephone service now stands at over 550,000, inclusive of those whose applications are in course of provision; of these, 36 per cent are business applicants. Many thousands of these demands for service cannot be met until additional cable and exchange equipment is provided.

In 1942, the Post Office first introduced the present shared service system as a means of spreading out the available resources over the largest number of applicants. Since January, 1948, every residential applicant taking over an existing installation or being provided with a new installation or removing has had to undertake to share his line with another subscriber, but this does not mean that he will invariably have to share immediately but only when the necessity arises.

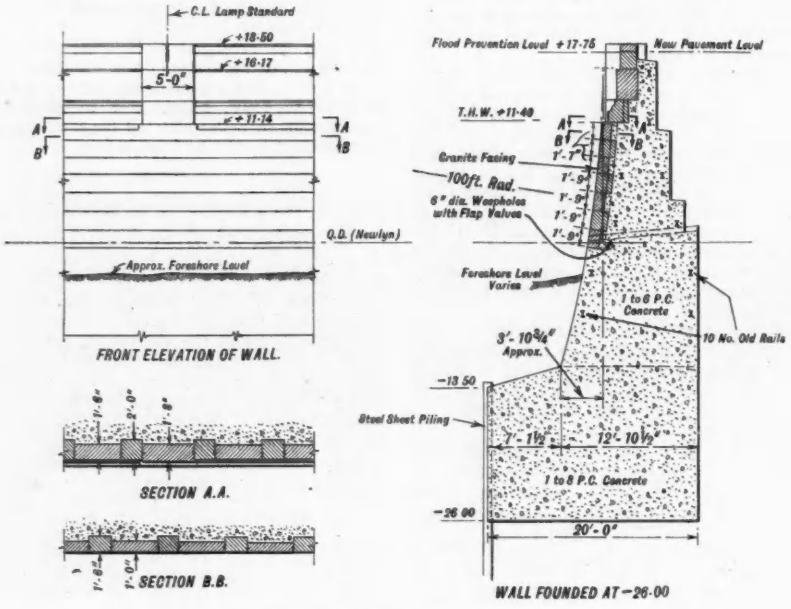
Over 230,000 subscribers are now sharing telephone lines, and of these about 60,000 are business subscribers. The Post Office states that the system is proving much more successful than was generally anticipated and that very few complaints of the service have been received from sharers.

NEW FIREPROOF BULKHEAD.—A new fireproof insulated bulkhead has recently passed a fire test at the Fire Research Station at Boreham Wood. It has been designed to meet the new international regulations for safety of life at sea, and is produced by Durasteel, Ltd., Greenford, Middlesex, in association with John Brown and Co., Ltd.

Progress of the South Bank River Wall

CONSTRUCTIONAL work on the South Bank of the River Thames on the Festival of Britain site is very active at the present time, and various structures, including the Royal Festival Hall and the Dome of Discovery, are rapidly taking shape. The basic task of building the new river wall and reclaiming some 4½ acres of foreshore from the River Thames is making good progress, and the latest estimates indicate that the new wall will be completed by September. In our issue of January 21, 1949, page 85, we gave a description of the new wall, the construction of which had just been commenced, together with some historical notes about the site. Now that the work is approaching completion it is possible to describe some of the methods used and difficulties encountered during the course of its construction.

A cross section of the river wall is shown in the accompanying illustration. The section shown applies to a length of 366ft of the wall near the County Hall, which was founded at a level of −26 O.D. on London clay. On this part of the site the river mud lies on a thin layer of ballast and the London clay underlies the ballast. Further downstream the thickness of the ballast layer increases to about 20ft, so that the wall was founded on the ballast at a higher level in this part of the site.



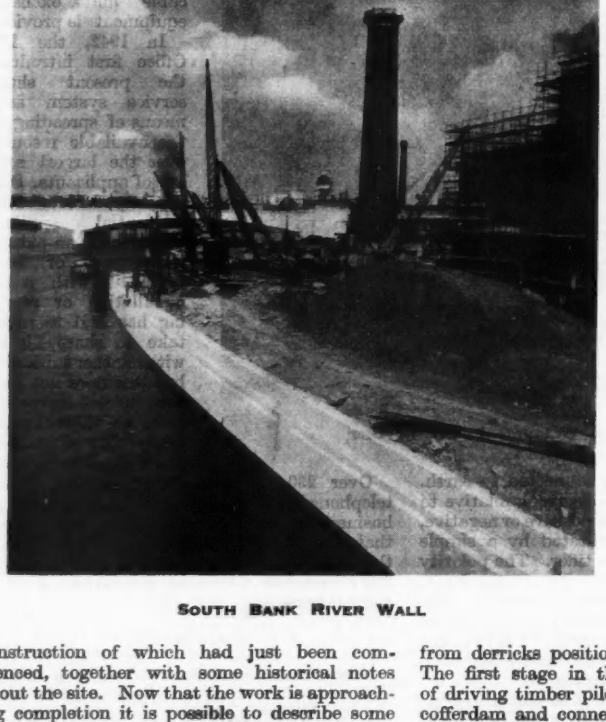
ELEVATION AND SECTION OF WALL

The wall was constructed inside a steel sheet piled cofferdam, all the piling being driven from derricks positioned on the bank nearby. The first stage in the construction consisted of driving timber piles outside the lines of the cofferdam and connecting them together with walings, struts and diagonal bracing to form a preliminary framework to support guides at two levels for driving the cofferdam piles. This framework also served for access, for setting out, and for fendering protection on the river side. The steel sheet piles, which were Appleby Frodingham No. III section, generally 52ft long, were then driven to a penetration of about 8ft below foundation level. As the higher formation levels were reached, however, the piles were driven to a minimum of 4ft penetration into the clay stratum, thus ensuring a water seal throughout the work.

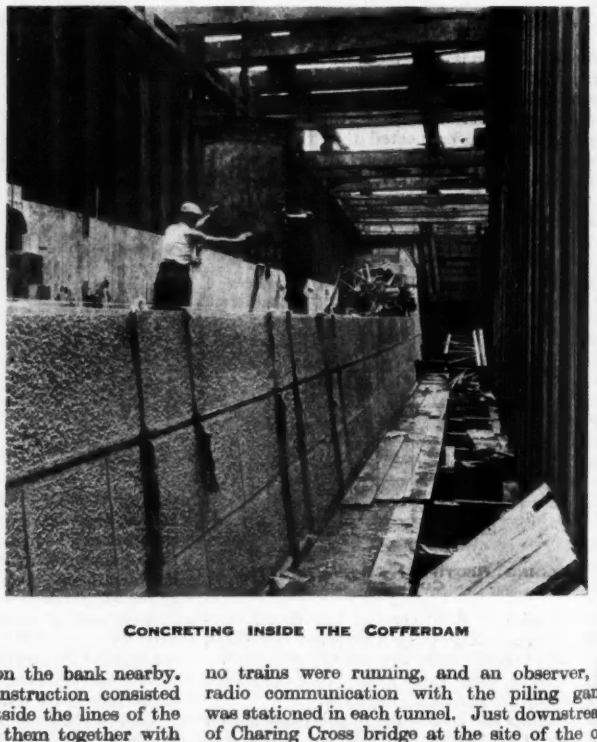
The cofferdam was built in lengths varying between 80ft and 160ft, corner piles being driven to form the returns. The steel piling was driven accurately to line, since the front row of piles was flame cut to form a permanent cut-off at the toe of the wall, as shown in the illustration, and the piles on the shore side formed the shutter for the back of the lower part of the wall. The piles were used several times, an interesting point being that the half-lengths extracted from the front row after cutting were welded together and used again.

The cofferdams were braced with walings made up of double 6in by 16in by 62 lb rolled steel joists, strutted with double 12in by 12in timbers at 10ft 6in centres. Near the top of the dam, 2in diameter mild steel tie bars were provided at 10ft 6in centres, attached to 12in by 12in timber walings positioned on the outside of the piling walls. Five frames of walings were used in that part of the wall founded at −26 O.D., at levels of −21, −16, −10, −2 and +14. The top level of the piling was +17·75 O.D. Further downstream, where the formation level was −18 O.D., three frames of walings were used at levels of −11, +1 and +16·5. The top frame of walings was supported from the tops of the piles by hangers, and the lower frames were hung on steel rods from the top frame. At the returns, the double R.S.J. waling was fitted with steel angle cleats and with a short diagonal strut at each end so that it performed the dual function of strut and waling.

Great care was taken in driving the piling over the tunnels of the Bakerloo Underground line. The southbound tunnel, which is the higher of the two, has a top level of about −35 O.D., and the penetration of the piling was reduced over a length of about 30ft, so that the piles were 8ft clear of the tunnel. These piles were driven during the night when no trains were running, and an observer, in radio communication with the piling gang, was stationed in each tunnel. Just downstream of Charing Cross bridge at the site of the old Lambeth waterworks (which functioned from 1775 to 1837) some damage was done to the piling by an old 3ft diameter cast iron main



SOUTH BANK RIVER WALL



CONCRETING INSIDE THE COFFERDAM

which ran across both lines of piling and had to be dug out.

Another difficulty which hampered the work was the lack of headroom under Charing Cross and Waterloo bridges, which prevented the handling and pitching of the piles. When working under Charing Cross bridge it was decided to drive, first of all, piles just long enough to protrude above low-water level when completely driven, and then to make a fishplate joint and to attach the upper length. This method was, on the whole, satisfactory, although some difficulty was encountered in caulking the joints. Under the Waterloo bridge, however, the piles were kept in one length, but parts of the interlocking elements were cut off. By carefully arranging the remaining interlocks on adjacent pairs of piles it was possible to pitch a pile by bringing it against the last driven pile at a point, say, halfway up the latter at the lowest accessible level instead of at its top.

The wall itself was built of 6 : 1 and 8 : 1 weigh-batched concrete, and was set out in plan to a curve of 2026ft radius from the County Hall to a point near Charing Cross bridge and to curves of 2450ft and 1400ft radius further downstream. Its total length is 1700ft and it is provided with a set of watermen's steps.

Keyed expansion joints, formed by ½in wide fibrous sheets with water seals, were incorporated at intervals of about 180ft. Old rails were cast in the concrete to resist thermal movements, but no other reinforcement has been provided. The granite masonry was set to a high degree of accuracy, the work being complicated by both horizontal and vertical curved surfaces. The illustrations opposite give an idea of the pleasing appearance of the finished masonry surface, although the wall is incomplete in these reproductions.

At the present time the last length of the cofferdam just downstream of Waterloo Bridge has been driven and construction of the wall at that end is proceeding. Downstream of the bridge a steel piled return wall curves sharply to join the old line of the existing river wall. Further upstream work is proceeding on the top lifts of the wall. The completed cost of this work is estimated to be about £400,000, of which about £150,000 covers the cost of supplying the granite facing. The granite blocks have been supplied by Cooper Wettern and Co., Ltd., and the wall has been built by Richard Costain, Ltd., to the design of Mr. J. Rawlinson, M.I.C.E., chief engineer of the L.C.C.

A Hob Flank Angle Measuring Machine

We illustrate herewith a machine which has been developed by the Coventry Gauge and Tool Company, Ltd., of Coventry, for checking by direct measurement the form of involute helicoids and other helicoids straight sided in the normal or axial planes.

The machine has a substantial base cast integral with pillars at each end carrying adjustable centres between which the work is mounted. A table on the vee and flat ways of the bed is traversed by means of a graduated handwheel and has mounted on it a swivelling table carrying a cross slide. This cross slide, which is moved through a graduated handwheel, carries a stylus-actuated sensitive indicator on which deviations from the straight line generator are shown. The indicator has a five-to-one magnification and the instrument usually fitted is graduated in 0·0005in divisions, one division on the dial being equivalent therefore to a movement of 0·0001in of the stylus.

The indicating unit is mounted on pillars on which it is adjusted vertically for setting the stylus to the correct plane by means of a standard height block. This block *A* can be seen in position between the underside of the indicating unit and a pad between the bases of the pillars in our illustration. The correct setting of the stylus on the axis of the centres is checked by means of slip gauges and a dial gauge when preparing the machine for inspecting helicoids. For fine pitches the point of the stylus is set on the axis of rotation. When it is required to inspect helicoids straight sided in the axial plane no further vertical adjustment is required.

The swivelling table is set by inserting slip gauges between the cylindrical stud *B* on the main table of the machine and the pad face *C* on the swivelling base.

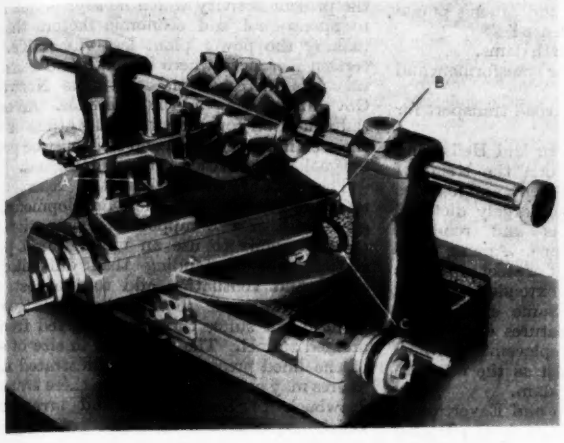
A 4·03576 combination of slip gauges is used when setting the traverse of the stylus normal to the axis of the centres; this corresponds to the combination required for setting a 55 deg. angle on a 5in sine bar. To traverse at an angle of x deg. from the normal the required combination is given by the formula $5 \times \sin(55 - x)$.

For inspecting helicoids straight sided in the normal section the stylus is required to traverse in a plane offset from the line of centres. The degree of angular setting of the swivelling table and slip gauge combination required for this and the height setting of the indicator unit can be readily calculated.

When measuring involute worms on the machine, according to the angle of helix, the stylus is set above or below the worm axis by an amount equal to the base circle radius, and the swivelling table set to the base lead angle of the worm. When the machine is set for either flank of a symmetrical worm thread the opposite flank can be checked by reversing the work in the centres.

By using slip gauges calculated by formula gear hobs with straight or with helical flutes and with relieved cutting edges can be checked on the machine.

The "Matrix" profile recording instrument made by the company can be used on this machine to trace on a smoked glass plate, either in an axial plane or normal to the helix of the profile, the true profiles of hobs, worms, gears, or any section which is difficult to project.

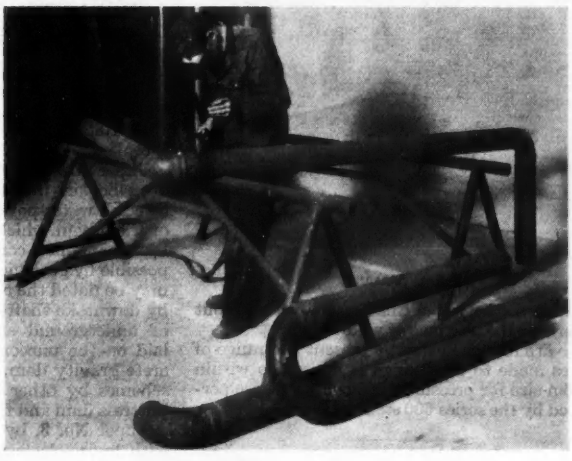


HOB FLANK ANGLE MEASURING MACHINE

Butt Welding Fittings for Pipe-lines

In order to make possible the extended use of butt-welded fittings in the construction of all-welded pipe-line systems, Stewarts and Lloyds, Ltd., has placed on the market a range of fittings to match Class "B" tubes to British Standard 1387. These fittings, comprising 45 deg. and 90 deg. elbows and 180 deg. return bends, are made by the firm in a range of sizes from 1¼in nominal bore to 6in nominal bore inclusive, the standard radius being one and a half times the nominal bore.

The fittings are produced in the maker's works under controlled conditions by a process which is designed to avoid creasing on the inside or thinning on the outside of the bends.



WELDING FITTINGS TO TUBES

There is no flattening of the cross section, and, since the fittings are made to the same outside diameter as the tubes with a high degree of concentricity, their use makes it possible to produce first-class welded joints.

The fact that the fittings are made to short radii makes it possible to fit the resulting pipework into cramped spaces, and work can often be proceeded with without lay-out drawings. By using such fittings and their tubes drawn straight from stock, the necessity for hot or cold tube bending in the shop or on site can be avoided.

In the photograph reproduced above a typical pipe-line using the fittings can be seen in course of assembly by welding at an installation site.

Valves for Oil Refineries

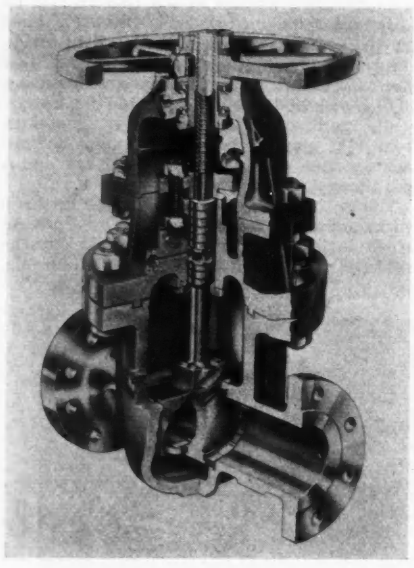
We reproduce overleaf a sectional photograph showing the construction of a new design of outside rising screw valve which is now being made by Metaducts, Ltd., of High Street, Brentford, Middx, for use in oil refineries and in oilfields. It complies in all details with the requirements of B.S. 1414/1949.

The cast steel body of the valve is fitted with screwed-in and bottom-seated renewable forged seatings of austenitic steels selected to reduce the possibility of mechanical seizure. A large tee-head, forged and machined on the valve stem, moves the wedge in full length guides in the body. This wedge is fitted with renewable seating rings which can be either welded in position or pressed in and peened over as required.

The stem moves in a long stuffing box which is fitted with a wide split-gland bushing or lantern ring for lubricating purposes. When the valve is fully open the stem head seals against a back seat bushings to permit repacking of the stuffing box under pressure. When the stuffing box is being repacked the gland can be supported on rests provided on the inner sides of the yoke bearing housing to give unobstructed room for working in. If specified an alternative stuffing box can be provided with

a condensate chamber and a drain from the bottom of the box.

The handwheel assembly is mounted on heavy double-thrust bearings in the yoke housing and,



OIL VALVE

if required, the wheel can be removed without disturbing the bearings or yoke sleeve.

We are informed that at present the range of valves made to this design is limited to within the 6in size for pressure ratings up to those permitted by the series 600 standards.

Mechanisation in Australian Steel Industry's Collieries

As far back as 1939 mechanisation was well established in the Broken Hill Proprietary's Collieries on the Newcastle (N.S.W.) coalfield. Plans were also afoot for mechanisation of the southern collieries of an associated company, Australian Iron and Steel, Ltd. As wartime circumstances made it impossible to import the cutters, loaders, battery locomotives and other equipment required, it was decided to undertake manufacture in Australia. Designs of loaders and cutters were based on well-known American types made by the Jeffrey Manufacturing Company of Ohio. That company gave full co-operation. By August, 1949, the Newcastle Steel Works of B.H.P. had made eighty-eight 10-ton battery locomotives for underground service. A target of 116 units is planned. It is expected that the rate of output will be two units a month. Each locomotive is driven by two flameproof electric motors, which, with the exception of the bearings, are completely fabricated at the Newcastle Steel Works. It is intended to standardise on 10-ton wagons in all the collieries of Australian Iron and Steel, Ltd. They are being built by several engineering firms in New South Wales and already a great number have been delivered.

The wagons have an overall length of 17ft 8in, a width of 7ft, and height above rail of 4ft 6in. They are of the solid-bottom, axleless type, and are constructed to designs secured from the Differential Car Company of America. The coupling arrangement between cars enables each car to be inverted individually to discharge its load without need for uncoupling.

NEW HEAVY DIESEL TRACTOR.—Vickers-Armstrongs, Ltd., announces that it has been developing a Class I heavy track tractor specially designed for industrial and heavy agricultural work. The new tractor, the "Vickers," is intended principally for the export market and it is hoped to commence full production by 1952, after a period of practical tests under user conditions. Weighing between 14 tons and 15 tons, the tractor will be powered by a Rolls-Royce six-cylinder diesel engine developing 180 b.h.p. at 1800 r.p.m.

Fourth World Power Conference

No. IV—*(Continued from page 105, July 28th)*

SECTION H1.—WATER POWER—RESOURCES AND LOCATION OF PLANT

By SIR WILLIAM T. HALCROW, M.I.C.E., M.I.Mech.E.†

IN this section, thirteen papers have been received, covering hydro-electric development in many countries.

Some of these papers are of a statistical nature and deal with the growth of power development; others lay emphasis on the trend of design, while some cover both features.

Paper No. 1, by Holden, records the rapid progress made in power development in Canada, largely stimulated by the demands of the second world war. The paper describes in general terms the trend in design, and among points which may be specially noted are :

(1) The increasing use of earth dams.

(2) Extended use of outdoor transformers and switches.

(3) Replacement of rail by road transport for the plant.

Paper No. 2, by Westerberg and Hellström, describes in interesting fashion the trend of Swedish water-power development, and features of the design which have been largely dictated by economic considerations and rendered possible by geological conditions. Among these may be noted the replacement of steel pipe-lines by downtake shafts, and the extended adoption of underground stations. Some emphasis is laid on the uneconomical features of the concrete gravity dam, and its replacement in new schemes by other types, such as the concrete buttress dam and the rockfill dam.

Paper No. 3, by de Luccia and Eaver, deals with hydro-electric development in the United States. Points which may be noted are :

(1) Larger size of units, following the linking-up of power systems.

(2) Increase in the head under which both Francis and Kaplan turbines operate, 925ft and 100ft having been reached in installed plants respectively.

Design has been particularly influenced by the economic factor of rising costs of labour and materials.

Paper No. 6, by Harnecker, on the hydro-electric resources of Chile, states that the possibilities in central Chile described in a paper read at the Third World Power Conference in 1936 have now been largely realised by systematic electrification of the country during the past ten years. In his present paper, he draws particular attention to large potentialities near the coast which are likely to be of special service for electro-chemical and electro-metallurgical industries.

Paper No. 7, by Stoffel, and paper No. 8, by Gadkary and Thacker, both deal with India. The former paper deals with the possibilities of industrial development arising from the great potential water power and the richness of its mineral deposits. The second paper indicates the rapid growth of hydro-electric development in India in the last few years. The present installed plant is about $0{\cdot}5\times10^6$kW, and projected plant is no less than $5{\cdot}7\times10^6$kW. The potential power is given as between 30×10^6kW and 40×10^6kW.

In paper No. 9, Slebinger endeavours to assess the total water-power resources of the world, and arrives at a total of 5600×10^6kW, based on arithmetical mean flow.

Paper No. 10, by MacColl, discusses the development of water power in the Highlands of Scotland. The estimated potential is 6300×10^6kWh per annum, or roughly one sixth of the present load on the grid. Water power can, therefore, make a substantial, though localised, contribution to the power requirements of the country, but can never become a dominant source of power.

Paper No. 11, by Way, will be of particular interest to electrical engineers, as it deals with the current practice and future trends in power transmission and distribution and particularly with the interconnection of systems.

† Sir William Halcrow and Partners.

SECTION H2.—WATER POWER—DESIGN OF POWER STATIONS

By A. A. FULTON, B.Sc., M.I.C.E., M.I.Mech.E.*

PAPER NO. 1: NORWEGIAN HYDRO-ELECTRIC POWER STATIONS BUILT INTO ROCK: HEGGSTAD (N)

In his paper the author points out that in Norway underground power stations are not new, as the first one was completed in 1921. Experience with this and other early stations has been free from trouble, and has encouraged the present activity which he says is due more to operational and economic factors than to making the power plant less vulnerable. In certain instances where underground construction has increased the cost, the Norwegian Government has paid the difference. An essential condition for underground stations is that the rock must be sound, and this must be proved by geological investigations beforehand.

The author summarises the reasons for underground power station development, but gives no figures to support his contention that it is economic to use an underground power station, notwithstanding that difficulties of access and ventilation add to the cost. No reference is made to any disadvantages the plant might suffer through being fed from an unlined tunnel. The smallness in size of some of the lined pressure tunnels illustrated in the figures may occasion comment; there is another drawback to the underground arrangement which has not been mentioned, namely, that the whole station must go out of action if any one of the individual pressure shafts serving one of the units of a multi-unit station is causing trouble.

PAPER NO. 2: HYDRO-ELECTRIC POWER—DESIGN AND OPERATION OF POWER HOUSES AND EQUIPMENT: STROWGER (U.S.)

Strowger, in his review of American design and operation of hydro-electric power houses since 1936, quotes the extent to which outdoor and semi-outdoor installations continue to be used, and in an effort to reduce capital costs the extent to which standardisation and the use of duplicate machinery is developing. Table I in the paper shows that the capacity of recent outdoor and semi-outdoor installations amounts to nearly $1{\cdot}75\times10^6$ h.p. The size of units has also been stepped up greatly with the use of Francis and movable-blade turbines extending into the higher ranges of head. As examples, he mentions the 150,000 h.p. Francis turbines at a head of 330ft at Grand Coulee, and the 111,300 h.p. adjustable-blade turbines under 80ft head at McNary Dam on the Columbia River. Fuller particulars are given of the Nantahala turbine, which, with an output of 60,000 h.p. at a maximum net head of 1000ft he believes to be the highest-powered high-head reaction turbine in the world.

The author illustrates how all the operational advantages of a Pelton wheel were obtained in the case of the Bridge River development in British Columbia, by adopting a vertical arrangement and using six jets to develop a total of 62,000 h.p. per machine at a net head of 1118ft.

PAPER NO. 3: GENERAL CONSIDERATIONS ON THE SIZE OF HYDRO-ELECTRIC POWER PLANTS: ROUSSELIER (F)

Rousselier draws attention to the steady increase in size in hydro-electric power plants which has taken place on the last fifty years, and suggests that, for Europe at least, the economic limit of size has now been reached.

In support of his theory he examines the limits which govern the size of the different sections of the work, the factors affecting the cost of

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production, and certain typically simple developments, to illustrate similar cases in nature. He shows how, in tunnels, geological considerations affect the maximum size; how, in lined pressure tunnels, the maximum practical thickness of the lining may be the controlling factor; how, in pressure pipe-lines, the limiting factor at present is the maximum diameter possible with banded pipe-lines; how, in dams, it is the maximum stresses which are allowable in the concrete and on the foundations; how, in generating plant, transport considerations, peripheral stresses, and cavitation are important; and how, in the power stations themselves, size can be a disadvantage. Even if not already limited by economic considerations, he concludes that there is little evidence at present of such technical revolutions which would permit of the foregoing limitations being overcome.

PAPER NO. 4: THE SUITABLE LAY-OUT OF LOW-HEAD HYDRO-ELECTRIC PLANTS BUILT NEXT TO WEIRS: CABELKA (CS)

The author relates the extent of the losses in output (from 1 to 10 per cent) and the increase in maintenance costs which have been experienced in Czechoslovakia with low-head hydro-electric plants built next to weirs at the convex (inner) bank of bends in canals or rivers.

PAPER NO. 5: HYDRO-ELECTRIC POWER—AVAILABLE POWER AND DELIVERY OF WATER TO THE POWER HOUSE: UHL AND OTHERS (US)

This review of progress in the United States since 1936 covers conveyance of water to the power house, and so is complementary to Strowger's review of the design and operation of power house and equipment. In the field which they cover, the authors state that increased efficiency is the keynote, with a desire for simplification, standardisation, and where possible, duplication. They cite examples of special trends which include:

(1) Peak-load operation of hydro-electric plant in combined steam and hydro-electric systems.

(2) Developments of greater magnitude, with the creation of head by dams, providing large storage reservoirs for seasonal stream regulation. Size of plant for many large projects limited by the difficulty of shipping runners in one piece.

(3) Diversion of flow from one watershed to another by tunnelling or by pumping to obtain a considerably higher head.

(4) Extension of multi-purpose river development programmes and the enaction of a law calling for the provision of penstocks for power production at all dams which have been authorised.

In the section devoted to construction methods, the following points are made:

(1) Size of equipment used:—	
Trucks, cubic yard	45
Shovels, cubic yard	5
Concrete mixers, cubic yard	6
(2) Speed of construction:—	
Concrete placing, cubic yards per month ...	398,000
Concrete production per plant, cubic yards per 24 hours	10,000

Cement and concrete are being transported in pipe-lines by compressed air, and the employment of larger mixers has permitted the use of aggregate up to 6in in size, and given satisfactory mixes with three bags of cement or even less to the cubic yard. Tests show that concrete with air entrainment admixtures, which is being extensively used, gives greater durability, making it of special value for hydro-electric structures. To minimise cracking, pre-cooling of concrete ingredients before batching is now preferred to the older method of cooling the concrete by circulating refrigerated water.

SECTION H3.—WATER POWER—ASPECTS OF PLANT DESIGN

By E. N. WEBB, D.S.O., M.C., M.I.C.E., M.I.E.(Ind.)*

Successful extension of the reaction turbine field up to heads of 1640ft is perhaps the most noteworthy achievement in which Norway takes the foremost place. The significance of this advance to the electricity supply industry lies in making available generating sets of larger individual capacity and higher speed, at lower cost per kilowatt and lower installation cost overall. Operating experience, though not yet extensive, promises to be satisfactory.

The critical features of such turbines are the tightenings at all moving surfaces subject to water pressure, and the passages in the runner; it would be most interesting and valuable to hear further on these features from both Norway and Italy. Production of the runners with adequate accuracy and finish of the narrow passages for the exacting head conditions is perhaps the most important and difficult aspect on which more details would be welcomed.

Emphasis is rightly placed on the unsuitability of high-head reaction turbines for operation at low loads. In that range of small gate openings, the runner inevitably is subject to the harmful effects of cavitation. Despite its inherent and sustained high efficiency, high rotational speed, and compactness, the encroachment of the high-head reaction turbine on the impulse turbine field will continue to depend on various factors outside the design and production of the machine itself, e.g., condition of the water and nature of the load demand. Also, the application of the vertical-shaft multi-jet impulse turbine should not be overlooked.

Papers Nos. 1 and 4 both submit graphs illustrating the ranges of hydraulic conditions for which the several types of turbine have been applied. From these alone as well as from contemporary comments and records, it will be evident that the province of each type is very loosely delineated, and later developments tend to increase the overlap.

An aspect of great general interest is the persistent trend towards larger generating sets, larger in output and also in physical dimensions. This is even more an economic and commercial than a technical problem. Research and extrapolation of existing designs can ensure that the purely technical requirements will be met, but the provision of workshops, machine tools, transport facilities, &c., on almost a revolutionary scale means an extremely heavy charge on industry in time, cost, and limited application of specialised plant. These considerations indicate the importance of examining all available evidence and portents from which reliable deductions of the future requirements in this respect can be made. The appropriate compromise can only be worked out between the manufacturer and the user whose views are conditioned by local needs and preferences, and by developments in the nature of load demand. Also the large generating set is not a purely hydraulic problem, and the generator design in several respects becomes the determining factor. Nevertheless, there is little doubt that the limit in size from both angles will continue to be extended.

Nechleba presents a welcome treatment of Kaplan runner blade design, whereby this may be simplified over its wide ranges of application. There exists a considerable degree of ignorance as well as of unbelief regarding the use of high-head Kaplan turbines which have been for many years in fully satisfactory operation in European countries under heads up to 164ft. The paper does a signal service in underlining this achievement by quoting the practical design of a Kaplan runner for upwards of 200ft head with favourable cavitation characteristics; this derives from the use of aerofoil form for the blade sections.

Paper No. 3 also emphasises the inter-relation of head, specific speed and number of blades for satisfactory design of Kaplan runners; with increase of head, the number of blades must be increased to avoid cavitation and to distribute the greater forces involved. Thus, the practical choice varies from three blades for low-head high specific speed turbines, to eight for high heads above about 130ft. There is no firm rule with respect to number of blades, each manufacturer following his own individual practice which appears to be determined to some extent by the mechanism used for turning the blades.

The evolution of storage pumping sets on the grand scale described by Ucelli is quite an outstanding achievement, reflecting the exceptional combination of natural conditions which obtains in Italy. Pumps absorbing 61,000 h.p. and 40,000 h.p., delivering against heads of 940ft and 1960ft respectively, are remarkable *per se*, quite apart from their incorporation in hydro-electric accumulator schemes with attendant special problems. The introduction of an axial flow feeder pump to overcome suction difficulties, and of an automatic by-pass to simplify regulation, are ingenious solutions of two such problems. While application of the pumped storage system is bound to extend, in most countries its adoption will be slow for lack of the favourable natural conditions which are necessary to render it economic by comparison with competing supplies of energy.

SECTION J.—ATOMIC ENERGY

By NORMAN ELCE, M.Sc., Tech., M.I.Mech.E.*

Liljeblad, Cockroft and Davidson all conclude that at least the initial power plants are likely to be dual-circuit systems, employing a primary circuit which transfers heat from the reactor to the motive fluid of a heat-engine circuit. In the present state of knowledge, the lay engineer will probably accept this conclusion; a single circuit system would appear to have these specific disadvantages:—

(1) It requires the selection, discovery, or creation of a motive fluid which is suitable also for the reactor. It would appear that helium is the only known or probable medium combining a sufficient number of the necessary properties.

(2) It requires the whole of the plant to be within the protective casing.

(3) Maintenance is difficult, perhaps impossible. Heretofore, power plant has evolved on a basis of accessibility, and employs many expendable or adjustable elements of construction. The effort to replace these by wholly permanent substitutes is most unlikely to succeed.

(4) The probability of fortuitous breakdown is unpredictable except in so far as it must be assumed that it will occur somewhere or other within any reasonable plant life. Such breakdown might have consequences which no robot could repair.

The problems of an inaccessible circulating system, if less serious than those of an inaccessible prime mover, are still very formidable. The engineering approach to these largely mechanical problems is controlled by the probability, the extent, and the persistence of radio-toxicity in the parts of the circuit—of the primary circuit in a dual-circuit system; of the whole circuit in a single-circuit system—external to the reactor.

What is apparently contemplated, at least as a possibility, is a primary circuit, for example, helium at a pressure of several hundreds pounds per square inch, as nearly as possible hermetically contained. A helium circuit of the type and dimensions implied cannot easily be entirely hermetic. Assuming some form of rotary circulator, as seems likely, there is no gland which will supress all the leakage all the time; the engineer must be instructed as to whether or not the irreducible minimum leakage can be suitably disposed to waste, or processed for return to the system.

Alternatively the circulator unit may be wholly enclosed in a pressure vessel in an atmosphere, also, presumably, of helium, at a pressure properly related to that in the primary circuit. But the conventional and probable lubricant is oil, and there is no means of ensuring that this will not escape, at some rate and in some form, into the ambient atmosphere within the pressure vessel. It can indeed be positively excluded from the primary circuit, where presumably it would be unwelcome from every point of view, but only at the cost of maintaining an outward leakage from the circuit, at the circulator glands, into the pressure vessel. In turn, a balancing extraction from the pressure vessel and a corresponding make-up into the primary circuit would have to be maintained, even, perhaps, when the circulator is at rest. From this point of view the pressure vessel is a

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device, and a rather brutal one, for minimising leakage and treatment problems or, alternatively loss and replacement of helium. Whether this is worth while presumably depends less upon the availability and cost of helium than on the disposal of the radiotoxic leakage.

Without underestimating the resources of engineering ingenuity, these problems of leakage and lubrication would appear to apply to any large-scale mechanical pumping system, whatever the medium circulated. It is therefore with some reluctance that Davidson's exclusion of an evaporative-condensing primary cycle is accepted. Subject to the solution of the nuclear problem, a cycle of this kind has decided advantages; in particular it provides the possibility of a purely thermal circulation, and the avoidance of all moving machinery in the primary circuit. Notably, Davidson says only that the system creates serious control problems; it is to be assumed that these have been considered in comparison with the problems, perhaps equally serious, of a mechanically sustained circulation. Alternatively, again premising the availability of a medium of acceptable nuclear properties, a purely convective circulation would appear a little less bizarre than some other conditions of the project. Thermal circulation preferably in multiple parallel circuits, is so potentially attractive, in its independence of moving machinery, in ready adaptation to a hermetic arrangement, and in relation to the servicing and maintenance of all the radioactive and possibly radiotoxic elements of the circuit, that its rejection must imply quite overriding limitations.

The normal economic criterion is the annual cost of generation, deriving from the capital charges, which may include a rate for maintenance and attendance, and the annual fuel costs. Algebraically simple enough—with some reservations as to the incidence of development charges—but arithmetically insoluble, since neither the capital costs nor the cost of fuel can be even approximately known without preliminary expenditure of the order indicated by the investments of the United States quoted by Davidson. The economics of nuclear power production appear, therefore, to be well within the field of qualitative speculation, but it is to be noted that the forecasts here presented are decidedly more conservative than some past, and even some contemporary claims.

SECTION K.—OTHER SOURCES OF ENERGY

By C. W. Marshall, B.Sc.(Eng.), M.I.E.E.*

Paper No. 1: Recent Developments in Large-Scale Wind Power Generation in Great Britain: Haldane and Golding (GB)

This summarises some results of a special wind-power survey at selected points on the north and west of Great Britain.

The authors estimate that if the upper limit of price obtainable for wind-generated electrical energy is 0·4d. per kilowatt hour, the cost of the generating plant, including connections to a power system, must not exceed £80 per kilowatt when the annual energy output is 4000kWh per kilowatt.

Paper No. 2: The Application of Natural Steam to the Production of Electric Power: Virgili (I)

This paper describes a unique and epic achievement in engineering history. Power from volcanic sources in the district of Lardarello, near Volterra, in Tuscany, has been used in an almost continually increasing degree since 1928, and now constitutes an important contribution to Italian industry.

The achievement is scientifically and technically of world importance. The information provided will stimulate engineers and others to emulate Lardarello in other parts of the world where geothermic energy is available. Even the brief indications of difficulties and dangers encountered in the Italian development will help to this end.

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Paper No. 3: Industrial Utilisation of the Differences of Temperature between the Deep and the Surface Waters of the Seas: Beau and Nizery (F)

The poineer efforts of Claude to utilise the thermal energy in sea water are now being followed by a project at Abidjan on the Ivory coast.

Paper No. 4: Heat Pump Progress in the U.S.A.: Sporn, Ambrose and Baumeister (US)

There are 500 heat pump installations in the U.S.A. They range in capacity from 3kW to 460kW, and represent a total connected load of 6200kW.

The chief application is to continuous air conditioning, i.e., space heating in winter and cooling in summer. Co-ordinated research and development is being conducted by electricity supply interests, electrical and mechanical engineering societies, and refrigerating, heating and ventilating, and air conditioning interests.

The chief hope for reducing the first cost of heat pumps is considered to lie in quantity production. It is considered that the heat pump has great potentialities for application to domestic water heating. Pilot plants for this purpose had average coefficients of performance of 1½ to 2½, but it is expected that hermetically-sealed compressor units will raise this figure to 3½ or 4.

A Symposium on Tapered Roller Bearings

Last week representatives from a number of universities and technical colleges attended a three-day symposium on tapered roller bearings, arranged by British Timken, Ltd. In the course of this symposium, three works controlled by the company were inspected and papers presented by various members of the staff of the firm were discussed.

On the first day the visitors were officially welcomed by Mr. F. J. Pascoe, the managing director of the company, and a tour was made of the Duston works, which is particularly concerned with the manufacture of the smaller sizes of tapered roller bearings. The tour was followed by a paper by Mr. D. McNicoll, the manager of the firm's Aston works. Mr. McNicoll's paper dealt with "The Contribution which the Universities can make to the Tapered Roller Bearing Industry assessed in the light of Anti-Friction Bearing History." In the course of this paper, he said that the industry would like to see tapered bearings take their place as a subject of academic study in universities in this country, as it offered a wide field for study both in teaching and in fundamental research. After a discussion of the paper, in which many views and opinions were expressed by the visitors, a second paper on "The Design of Tapered Roller Bearings" was presented by Mr. D. Ashton, the assistant works manager at Aston. At a dinner the same evening, Mr. Pascoe gave some interesting facts in connection with the firm's policy with regard to development and research, and the opportunities open to university graduates in the tapered roller bearing industry.

The Aston works was visited on the second day of the symposium and before a tour of the works was made, the visitors were shown a representative collection of the wide range of units and components made in the factory. This group of products was exhibited to demonstrate the many branches of industrial production involved in bearing manufacture, and the broad field of training open to students in the firm's works. The exhibition was followed by a paper on "The Application of the Principles of the Timken Bearing to Railroad Practice," by Mr. F. M. G. Wheeler and, in the subsequent tour of the works, the various stages in the manufacture of the large bearings described were open for inspection.

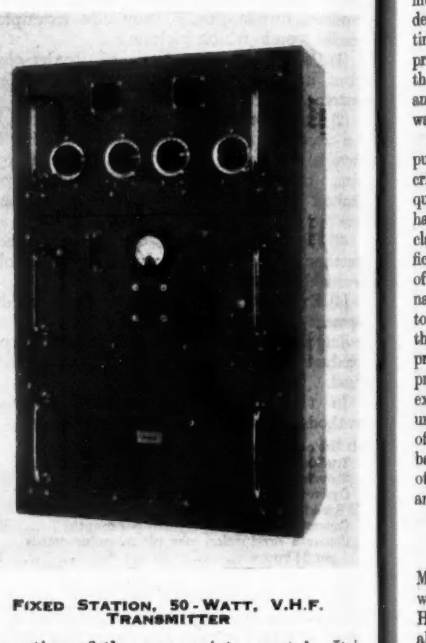
On the third and last day of the symposium, a visit was made to the works of Fischer Bearing Company, Ltd., Wolverhampton, a subsidiary company, and opportunity was given to see yet another aspect of bearing manufacture—ball and parallel roller bearings production. During the day a paper was read by Mr. J. H. Evans, on "Some Metallurgical Aspects of Steels for Tapered Roller Bearings," and a talk by Mr. E. R. Knapp dealt with the control of quality in the manufacture of tapered roller bearings.

The fact that each of the papers read during the course of the symposium was by a specialist in that particular field of bearing production gave the visitors excellent opportunity—which was by no means neglected—to present pertinent questions on any point of individual interest and obtain answers based on wide experience. Throughout the proceedings the answers to the questions were supplemented by practical demonstrations which were made available in the various departments in the works.

Fifty-Watt Fixed Station V.H.F. Transmitter

The 50-watt, V.H.F. transmitter, type PT.15, recently introduced by the Plessey Company, Ltd., Ilford, Essex, has a wide field of application in providing radio-telephony communication wherever a compact fixed station transmitter, with a carrier power output of the order of 50W is required. The complete equipment comprises an r.f. unit, a modulator combined with a control unit, and a power supply, each in the form of conventional 19in panels. As illustrated herewith, the three panels are supplied mounted one above the other in a robust metal cabinet, and provision is made for easy access to the components on each.

The set operates on a spot frequency within the 118-132 Mc/s frequency band, the crystal-controlled operational frequency being varied



Fixed Station, 50-Watt, V.H.F. Transmitter

by insertion of the appropriate crystal. It is then necessary only to tune for a maximum or minimum meter reading, according to the stage concerned. Where required, other frequency ranges between 70 Mc/s and 184 Mc/s can be provided to order. Frequency stability it is stated, fully complies with international requirements.

Operation is simple, bandpass circuits in the r.f. unit reducing the number of tuning controls necessary. Control is local, but "press to transmit" facilities can be extended up to 25 miles. A power output monitor may also be incorporated if required. The equipment operates from a 230V, 50 cycle mains supply. Servicing is simplified by the provision of switched meter indication of each stage in the r.f. unit, together with test points to cover all other sections. Pilot lamps mounted on the modulator front panel indicate l.t. "on" and h.t. "on."

Industrial and Labour Notes

The T.U.C. Agenda

THE eighty-second annual Trades Union Congress will open at Brighton on Monday, September 4th, and the preliminary agenda for it has now been circulated. There are seventy-six resolutions printed in the agenda, dealing, as usual, with a variety of matters of national and international interest. It is of interest to note, however, that no more than nine of the resolutions relate to wages, hours and conditions of employment, and that five of these call for the withdrawal of the Conditions of Employment and National Arbitration Order. In the section of the agenda headed "Industrial Policy and Organisation" fourteen resolutions have been tabled on matters relating to the efficiency of nationalised industries, the implementation of recommendations in working party reports, joint consultation in industry, and productivity.

A resolution submitted by the Association of Engineering and Shipbuilding Draughtsmen supports the view that the most important factors in increasing productivity are a rising trend of mechanisation and an extension of standardisation. But it notes the "continued high level of profits and believes that further measures should be taken not only to stabilise but to reduce profits." The resolution therefore calls upon the General Council of the T.U.C. to give every assistance and encouragement to affiliated unions to examine the problems of increased productivity in their own industry; to continue to press for full consultation between employers and trade unions before the introduction of new methods and processes designed to increase production; and to continue to press that the benefits of increased productivity should be passed to consumers in the form of lower prices on the home market and to workpeople in the form of improved wages and conditions.

The Amalgamated Engineering Union is putting forward a resolution on the economic crisis. This resolution declares that, in consequence of the economic crisis, a "greater burden has fallen on the workers than on the employing class." As a step towards an equality of sacrifice, the resolution recommends the suspension of interest payments on compensation in nationalised industries, except in needy cases, to be determined by committees established by the Government and the trade unions; the prevention of tax evasion and the hiding of profits by the opening of all company books and expense accounts to inspection by elected trade union committees; and the pressing forward of the extension of State ownership of all the basic industries, and the elaboration of a plan of production based "on the needs of the people and not on the needs of the capitalist market."

Industrial Investment

The Minister for Economic Affairs, Mr. Hugh Gaitskell, made a statement last week about industrial investment during 1950. He said that, altogether, it was expected that about £2,200,000,000 would be spent this year on gross investment in fixed capital assets at home, excluding additions to stocks and work in progress. About 20 per cent of the amount—or £450,000,000—was being devoted to manufacturing industry, including iron and steel. Particularly high priority, Mr. Gaitskell observed, was accorded to the iron and steel industry because of its basic importance for all types of development, and because engineering goods took so large a part in the country's export trade, providing, with steel exports, nearly half the total visible exports from the United Kingdom.

Another 10 per cent of total fixed investment, approximately £235,000,000, would be in the fuel and power industries, roughly half for electricity and the rest divided between coal and coke, gas and petroleum. The Minister said that investment in that field had been governed for a long time by the steady increase in demand for electricity and gas, and to that must be added the need for catching up with arrears of investment in the coal industry and in the construction of coke ovens, and, not least, the need for substantial oil refining capacity in this country. Another major sector of the capital investment programme, Mr. Gaitskell continued, was transport and communications, on which 15 per cent of the total, or about £320,000,000, was being spent this year. Here, much of the investment consisted of maintaining existing assets and catching up with arrears of replacement, since capacity more nearly matched demand than in other sectors of the economy. But about £55,000,000 was to be spent on new ships and refits.

Dealing in some detail with the progress being made in the various sectors of the nation's economy, Mr. Gaitskell pointed out that investment in new machines of modern design was a form of capital investment which could be expected to yield the most obvious and immediate increase in productivity. He said that deliveries of machine tools to the home market last year had amounted to approximately £28,000,000, compared with £20,000,000 in 1945, which represented a considerable increase even after allowing for rising prices in the intervening period. At the same time, the machine tool industry had made a valuable contribution to the export trade. Mr. Gaitskell went on to say that there were about 1,000,000 major-cost machines (valued at more than £75 each to-day) now installed in factories in this country, compared with an estimated figure of between 600,000 and 700,000 before the war. By introducing new types and designs of machines, either developed in Britain or manufactured under licence from foreign firms, the engineering industry, Mr. Gaitskell stated, would produce machines of a type not at present manufactured in this country. That, he suggested, should lead to a reduction of imports, particularly from the U.S.A.

Taxation of Profits and Income

Before the House of Commons rose for the summer recess at the end of last week, the Prime Minister, Mr. Attlee, announced that preparatory arrangements had been made for the wider inquiry into taxation which the Chancellor of the Exchequer intimated in his Budget speech would follow the inquiry being made by the Tucker Committee into the computation of trading profits. The Government, Mr. Attlee said, had come to the conclusion that the proposed inquiry should be a wide one, covering the incidence and effects of all the taxes on income and extending to the taxation of wages and salaries as well as of business profits.

The Prime Minister went on to say that he had recommended to His Majesty the setting up of a Royal Commission with terms of reference to the broad effect that it would inquire into the whole of the present system of taxation of profits and income, with particular reference to the taxation of business profits and the taxation of salaries and wages, keeping in mind the need for maintaining the revenue. The precise terms of reference and the composition of the Royal Commission would be announced in due course.

Engineering Wages

At the invitation of the Ministry of Labour, representatives of the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions met Sir Robert Gould, the Ministry's Chief Industrial Commissioner, on Friday last to discuss the possible resumption of negotiations on wages. Following the result of the Confederation's ballot, which proved opinion to be in favour of arbitration rather than strike action over the rejected claim for an increase of £1 a week, the Minister of Labour was asked to take appropriate steps under the Conditions of Employment and National Arbitration Order.

It is understood that at last Friday's meeting the employers and the Confederation of Unions agreed to the setting up of a small committee to discuss the matter further. This committee, it has been suggested, may reopen the subject of the new wages structure for the engineering industry, nogotiations on which have been at a standstill since the £1 a week claim was put forward last November.

Meanwhile, it was announced on Friday last by the Post Office Engineering Union that about 64,000 employees in the G.P.O. engineering and supplies departments were to receive pay increases, costing over £1,000,000 a year, under an award of the Civil Service Arbitration Tribunal. The award has been back-dated to June 1st. Commenting on the award, the general secretary of the Post Office Engineering Union said that the Tribunal had evidently followed the general pattern of Government policy, confining increases in the main to the lower-paid staff. In his view, however, the overall effect of the award was to narrow further the gap between the pay of high-skilled technical staff and lesser-skilled staff, and thus accentuated the problem of adequate pay for higher grade engineering posts requiring special study and training.

The British Institute of Management

The annual general meeting of the British Institute of Management was held in London on Wednesday of last week under the chairmanship of Sir Charles Renold. In an address, Sir Charles recalled that it was little more than two years since the Institute held its inaugural meeting, and in that short time remarkable progress had been made. The impact of the Institute had been wide, and contact had been made with a very large number of individuals and with companies of all sizes and in many industries.

Later in the address, Sir Charles referred to the formation of a "professional wing" and the granting of professional qualifications in general management. He said there was no doubt that, particularly among the younger men in industry and commerce, there was a strong demand for professional qualifications in general management having a significance which would be recognised by all employers. The existence of fully recognised qualifications would constitute a powerful incentive to the individual for self-improvement, and in the long run it was through increasing the efficiency of the individual manager that the Institute would achieve most towards its general object of raising the standards of management practice.

Changes in Wage Rates

According to the *Ministry of Labour Gazette*, changes in wage rates reported to have come into operation in the United Kingdom during June resulted in an aggregate increase of approximately £9000 in the weekly full-time wages of about 193,000 workpeople. Among those affected by the increases were workers in the iron and steel industry, ironstone mining and limestone quarrying in various districts, ballast and sand quarrymen, and workers employed in saw-milling, veneer production and plywood manufacture. In the iron and steel industry, the increases were made under sliding-scale arrangements based on the index of retail prices.

The Ministry's analysis shows that about £4000 of the total weekly increase resulted from the operation of sliding scales, about £3000 was the result of arrangements made by Joint Industrial Councils or other joint standing bodies established by voluntary agreement, and that most of the remainder of the aggregate increase resulted from arbitration awards. In the first six completed months of this year, changes in wage rates meant that approximately 2,277,000 workers received an aggregate increase in their weekly wages of £380,700. In the corresponding months of 1949, there was a net increase of £622,800 in the weekly full-time wages of 3,993,500 workpeople.

French Engineering News

(From our French Correspondent)

The French Economic Council has unanimously adopted a resolution stating that the European coal-steel pool plan is prejudicial to the Monnet Plan for modernising and equipping French industry, in spite of the fact that Monsieur Jean Monnet, Commissioner-General of the plan, is also the real author of the merger proposal.

On the other hand, Monsieur Jean Constant, president of the General Mechanical Industries Syndicate, stated that members of his organisation have accepted the idea of the pool without reserve. He said, however, that questions of social charges and taxation, which militate unfavourably, should be taken into account, and remarked that a mixed Franco-German commission was studying production in French and German works. He agreed that some French firms would fall by the way as a result of the pool, but thought that was necessary, as inefficient production had continued for too long. Where France was badly placed in supplying certain steel goods, he thought, the general interest made it imperative that these should be left to foreign production.

The pool is also mentioned in the report issued by the Sté. Schneider and Co., which does not oppose it but asks that basic conditions be considered. It is pointed out, for example, that a ton of coal of the same quality costs about 3000 francs for German industry but about 5000 francs for most French industries. Social charges also amount to only 23 per cent of salaries in Germany, against 45 per cent in France, and indirect taxation in France is 13·5 per cent, against 3 per cent in Germany. If the elements of basic production are not identical, the report continues, the least favoured cannot stand up to unrestricted competition. This declaration, it is believed, may be considered as reflecting the point of view of French steel industrialists. Even if the question of raw materials is settled, they would like to know whether finished products will also come under the combined authority.

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Saar coal has recently been exported to new foreign markets in Pakistan, Sweden, Denmark, Norway and Holland. The amounts sent to Sweden and Denmark are large and deliveries to Sweden in May were over double those for April. Sweden now occupies third place, after France and Germany, as a customer for Saar coal.

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The first two blast-furnaces at the Doneunkirchen steel works in Saarbruck have just been put in service, in the presence of the French High Commissioner and the President of the Saar Council.

* * *

The hydro-electric plant of Electricité de France at Ugine is increasing its output. The plant received 1387 million francs in Marshall Aid during 1948–49 and will receive further sums this year. The total cost of the new works will be about 3 milliard francs, and will enable a total of 40MW of installed power to produce 115 million kWh annually. As a result, steel production by the Ugine blast-furnaces will be increased by 80 per cent.

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Marshall Aid is also being used in the extension of highways in French Equatorial Africa, where it will purchase mainly heavy equipment such as bulldozers, heavy tractors and lorries. About 16 milliard francs will be spent over a ten-year period on these highway works.

* * *

The cable ship "Ampere," destined for Post and Telegraph Administration, was launched at the Chantiers de Normandie on July 1st. The vessel has been fitted with up-to-date equipment for the installation of co-axial cables. Its first task will be the installation of telephone cables linking Algeria and France. It is equipped with radar and ultra-sonic sounding apparatus. The "Ampere" has an overall length of 91 metres and gross tonnage 2100 tons. Its single boiler and two 2500 h.p. turbines give it a speed of 14 knots.

Notes and Memoranda

Rail and Road

S.M.M.T. PRESENTATIONS.—At the annual luncheon of the Council of the Society of Motor Manufacturers and Traders, held on July 20th, presentations were made to the retiring President, Mr. F. I. Connolly, who has been in office for the past two years, and to Mr. J. C. J. Phillips, who retired from the service of the Society in March, after acting as exhibition manager for over thirty years. The presentation to Mr. Connolly of a pair of antique silver salvers of Georgian design was made by Mr. W. Lyons, President 1950-51, on behalf of the members of the Society. Sir George Beharrell made the presentation to Mr. Phillips, and in proposing his health paid tribute to the knowledge and experience he had placed at the disposal of the Society throughout the many years during which he had been responsible for the organisation of the Society's exhibitions.

A.E.C., LTD., APPOINTMENT.—The directors of A.E.C., Ltd., have invited Mr. A. J. Romer, M.I. Mech.E., M.Inst.T., to join the board of that company and to assume the office of managing director. This appointment carries with it also election to the board of the parent company of the group, Associated Commercial Vehicles, Ltd. Mr. Romer has had a varied and wide experience of the heavy motor industry. After apprenticeship with John I. Thornycroft and Co., Ltd., he joined the Birmingham and Midland Omnibus Company as assistant engineer and transferred later to Eastern Coachworks, Ltd., as works manager. He has since become a director of the latter company. Subsequently Mr. Romer went to the Bristol Tramways and Carriage Company, Ltd., on appointment as general manager of the motor constructional works. He is also a director of the Bristol Tramways and Carriage Company, Ltd., and two of its subsidiaries. From 1943 to 1945 Mr. Romer was a director of Short Brothers, Ltd., in charge of aeroplane production. He assumes office with A.E.C. and A.C.V. on October 1st, next.

Air and Water

DUNDEE EXHIBITION.—At the Victoria Art Galleries, Dundee, the exhibition "Dundee-Built" of models and pictures portrayed the maritime history of Tayside over the last 150 years, including models of sailing ships, some of the earliest steamships, whalers and modern tonnage constructed by the Caledon Shipbuilding and Engineering Company, Ltd.

COASTING SHIPPING CONTROL COMMITTEES.—The Ministry of Transport announce that the coastal shipping control committees at London, Glasgow, Liverpool, Hull, Newcastle, Cardiff, Leith and Belfast will be disbanded after August 12th, and that future applications for licences should be sent to the Mercantile Marine Offices at the ports mentioned.

THE SECOND "COMET."—The second "Comet" aircraft made a successful first flight at Hatfield on the evening of July 27th, one year to the day after the first "Comet" took off on its maiden flight. After a preliminary run down the runway to test the wheel brakes, Mr. John Cunningham took the "Comet" off and was airborne for twenty-eight minutes. During the course of the flight the "Comet' climbed to 18,000ft. The aircraft has been ordered for the Ministry of Supply and will be used for further development flying by de Havilland test pilots. It is hoped that another "Comet" the first for B.O.A.C., and the first to be fitted with the four-wheel bogie undercarriage, will be flying before the end of this year.

BULK GRAIN CARGOES.—The Ministry of Transport announces that new regulations governing the loading and stowage of bulk grain came into force in Canada and the United States of America on August 1st. The regulations were formulated at a conference held in Ottawa, attended by representatives of the United Kingdom, Canadian and Australian governments and of the United States authorities. They have been agreed with the Chamber of Shipping of the United Kingdom and the Liverpool Steam Ship Owners' Association, and it is understood that Australia will adopt similar provisions at an early date. The new regulations embody relaxations in existing provisions, the chief of which are: in holds completely filled with grain, shifting boards will be required to extend downwards 8ft or one third of the depth of the hold, whichever is the greater, instead of the full depth as required previously; the carriage of loose grain will be permitted in bins in the 'tween decks instead of in bays as required previously on the North American Continent.

Miscellanea

MODEL ENGINEER EXHIBITION.—The Model Engineer Exhibition will this year celebrate its jubilee when it opens at the New Royal Horticultural Hall, Westminster, London, S.W.1, on August 9th.

THE LATE DR. D. H. BANGHAM.—We have learned with regret of the death of Dr. Donald Hugh Bangham, director of the British Coal Utilisation Research Association's laboratories at Leatherhead, which occurred on Saturday, July 29th. Dr. Bangham, who was fifty-five, joined the staff of B.C.U.R.A. soon after its formation in 1938.

TIME MEASUREMENT.—The Science Museum, South Kensington, has recently published a second edition of Part II of the "Time Measurement Handbook," which has been prepared by Dr. F. A. B. Ward, F.B.H.I. It contains detailed descriptions of the objects exhibited in the time measurement section of the Museum, ranging from primitive and other non-mechanical devices to modern electric clocks, controllers and time switches. Illustrations of several of the outstanding exhibits have been included in the catalogue, the price of which is 3s.

A FILM ON BEARING SURFACES.—Following its appointment as sole selling agents in Great Britain for the complete range of honing machines and equipment manufactured by the Micromatic Hone Corporation, Detroit, U.S.A., A. A. Jones and Shipman, Ltd., has now received from that firm a technical film entitled "Metallic Bearing Surfaces." This film shows the advantages of the honing process and also by high speed cinematography the resultant surface finishes obtained on all types of machining processes. The film, which is available in 16mm size, has a running time of approximately twenty-five minutes. It will be loaned to all interested firms on request.

O.E.E.C. EXPERT MISSIONS.—The Organisation for European Economic Co-operation states that two "expert missions" are visiting the U.S.A. to study cold storage and forestry problems respectively. The cold storage mission consists of fifty industrial and Government representatives from twelve O.E.E.C. member countries. Its principal object is to study the collection, transport and storing of frozen goods, and the manufacture and methods of use of refrigeration plant. The forestry mission numbers fifty-five timber experts from fifteen member countries. In four groups, the mission intends to study the exploitation of forests and transportation of timber; sawmills, veneer and plywood; the wallboard industry and utilisation of waste; and the marketing of timber and its semi-finished products.

NEW POWER STATION DEVELOPMETNS.—The British Electricity Authority has received the consent of the Minister of Fuel and Power to the development of three new power stations to their full capacity. The stations are Carrington near Manchester, Braehead near Glasgow, and Doncaster. The Minister's consent has already been given to the first stages of work at these stations. Authorisation has now been given to the installation of two turbo-alternator sets, each of 60MW and four boilers, each of an evaporative capacity of 360,000 lb per hour, at Carrington, which, when completed, will have a total installed capacity of 240MW; one 50MW set and two 300,000 lb per hour boilers at Braehead, which will have a total installed capacity of 200MW; and two 30MW sets and four 180,000 lb per hour boilers at the new Doncaster station, which will have a total installed capacity of 120MW.

PEMBROKESHIRE CEMENT WORKS.—Permission to erect a cement works and to win limestone and shale near the Pembrokeshire coast has been refused by Mr. Hugh Dalton, Minister of Town and Country Planning. The site proposed for these operations was at Lydstep, near Manorbier, Pembrokeshire, and it is stated by the Ministry that two-thirds of the site would have fallen within the area of the National Park proposed by the Hobhouse Committee. In giving his decision on the application, which in this case was referred to the Minister instead of being dealt with by the local planning authority, Mr. Dalton stated that any industrial development of the kind contemplated "would be out of harmony with the natural beauty of the area." He added that the works proposed would absorb very little labour from the Pembroke dock area, where there was some unemployment, and any such gain would be more than offset by the possible loss of employment in the agricultural and tourist industries. Nor was he satisfied that it was necessary in the interests of production for a new cement works to be built on the particular site suggested.

British Patent Specifications

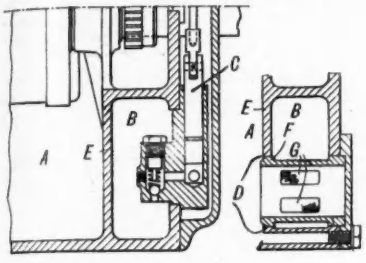
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2. 2s. each.

INTERNAL COMBUSTION ENGINES

639,813. February 20, 1948.—IMPROVEMENTS IN AND RELATING TO LUBRICATION SYSTEMS, John Constantine Grey, of 30, Osterley Court, Osterley, Middlesex.

This invention relates to improvements in forced feed lubrication systems, more particularly for internal combustion engines, of the kind in which oil is picked up from a sump or crankcase by means of a pump and is forced through appropriate pipes and/or passages to the parts to be lubricated and



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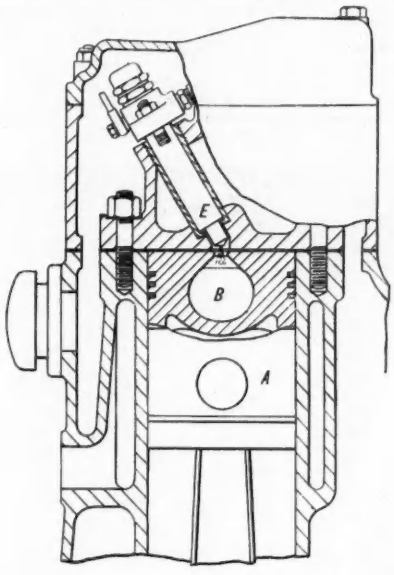
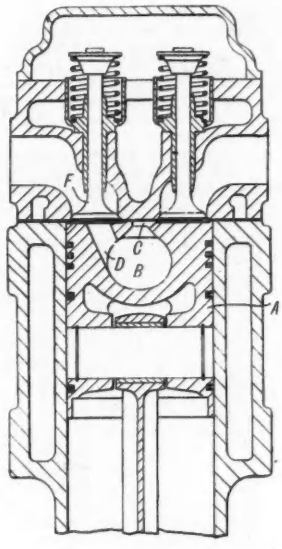
subsequently drips back into the sump or crankcase, the oil thus flowing in a circuit. According to the invention, the oil sump is divided into two compartments, one housing the pump and the other being the main compartment into which the hot oil is returned, communication between the main compartment and the pump compartment being through a filter. Thus it is ensured that the pump only picks up clean, stagnant and relatively cool oil. Referring to the drawings, the crankcase *A*, which comprises the main compartment into which the hot oil drips back, is provided at one end with a smaller compartment *B* supplying a reciprocating or other suitable oil pump *C* which is adapted to provide the forced feed lubrication of the engine in the usual way. The only communication between the crankcase *A* and the pump compartment *B* is by way of an aperture *D* in a wall *E* common to both, and this aperture is adapted to receive the open end of a cylindrical cage *F* carrying a gauze or other suitable oil filter *G*, the cage being inserted in position from the outside of the engine through a corresponding aperture in the opposite wall of the pump compartment. Hot oil from the crankcase *A* can therefore only enter the pump compartment *B* through the filter *G*, so that the oil in the pump compartment *B* will be clean, stagnant and relatively cool, which is, of course, the best condition for recirculation. Separate draining plugs are provided for the crankcase and pump compartment so that the filtered and unfiltered oil can be separated on draining the sump.—*July* 5, 1950.

638,583. September 25, 1947, and December 24, 1947.—IMPROVEMENTS IN COMBUSTION CHAMBERS FOR INTERNAL COMBUSTION ENGINES, Joseph Lambert Jameson, of Chessington Lodge, Spring Street, Ewell, Surrey.

This invention relates to the pistons of reciprocating internal combustion engines of the compression ignition type. According to the invention, a piston is formed so that within its body there is a combustion chamber having a fuel injection passage opening to its outer or head end and having also an air supply passage which also opens to the head end of the piston. From the drawings it will be seen that the piston *A* has formed within its body an approximately spherical combustion chamber *B* having a fuel injection passage *C* and an air supply passage *D*; both passages open to the outer or head end of the piston and the passage *D* extends in a sensibly tangential sense to the chamber *B*. The passage *C* registers with the discharge from a solid fuel injector *E*, while the passage *D* is disposed to register at its outer end, with the exhaust valve *F* of the engine; the air inlet valve of the engine is also indicated. When the piston reaches its outer position the two faces mate closely to one another so as to provide a very small clearance volume, and to enhance this effect pockets to receive respectively the heads of the valves are provided. The engine operates on the normal four-stroke cycle and during the inlet stroke of the piston the inlet valve is opened to admit air to the cylinder; during the compression stroke the piston compresses the air in the cylinder and the air passing into the chamber *B* through the passages *C* and *D* is caused to rotate and so to pass transversely across the end of the fuel injection passage *C* especially by reason of the tangential delivery of air through the passage *D*. When injection of the fuel takes place, air which is passing through the passage *C* from the decreasing





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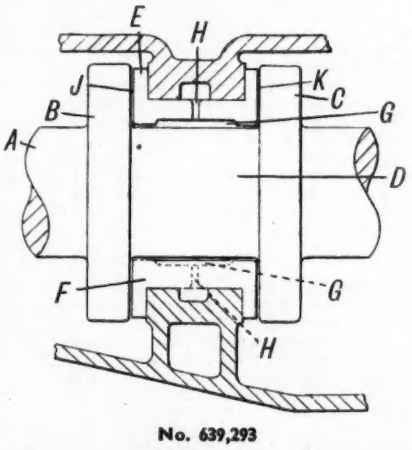
clearance volume between the face of the piston and the face of the cylinder head does so at high velocity and so effects atomisation of the fuel as it is injected into the passages; the air and fuel then encounter the air which is circulating in the chamber *B* where the process of atomisation is completed to give a highly combustible mixture which is self-igniting. Owing to the fact that the outer end of the air supply passage *D* opens in the end face of the piston at a region which registers with the area of the exhaust valve *F*, then towards the end of the compression stroke of the piston the air which enters the passage *D* necessarily passes the region of the exhaust valve and as this is the hottest part of the cylinder the air is heated to a high degree and conveys the heat to the combustion chamber *B* to produce vaporisation of the combustible mixture in the chamber and so the thermal efficiency of the engine reaches a high value.—*June* 14, 1950.

MARINE ENGINEERING

639,293. February 16, 1948.—COMBINED JOURNAL AND THRUST BEARINGS, Henry George Yates, of The Riding, Riding Mill, Northumberland; and The Parsons and Marine Engineering Turbine Research and Development Association, Wallsend.

The invention consists in a combined journal and thrust bearing comprising a split bearing furnished with a plurality of shallow recesses in the inner periphery. Each recess is supplied through a restricting nozzle with fluid under pressure in combination with a shaft having collars embracing the end faces of the split bearing with a suitable running clearance, contact between collars and bearing faces being prevented by the pressure fluid which passes through this clearance after leaving the journal portion of the bearing. In the accompanying diagrammatic drawing a shaft *A* is furnished with two collars or flanges *B*, *C*, the portion *D* of the shaft between the collars being housed within a split pedestal bearing *E* and *F*, the inner periphery



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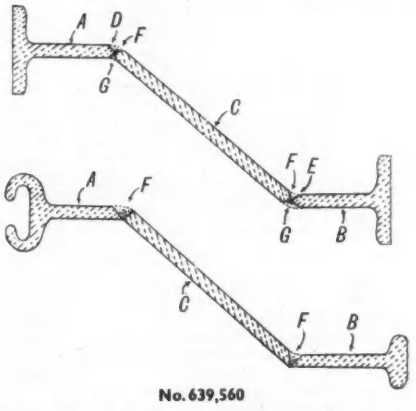
of which is furnished with a plurality of shallow recesses *G*, each recess being separately supplied with fluid through a restricting nozzle *H*. The clearances *J* and *K* between the collars *B* and *C* and the end faces of the split bearing *E* and *F* are such that contact between the collars and the bearing faces is prevented by the pressure fluid which passes radially through these clearances after leaving the journal portion of the bearing. Air may be employed as the pressure fluid. In a modified arrangement illustrated the split bearing members are supported respectively by the top and bottom halves of a machine casing, the fluid issuing from the clearance on one side of the bearing and entering the casing being of such nature that its presence there is not detrimental to the operation of the machine. If the machine is a steam turbine, steam may be used as the pressure fluid. The invention may also be applied to pedestal bearings.—*June* 28, 1950.

STRUCTURAL ENGINEERING

639,560. April 10, 1947.—IMPROVEMENTS RELATING TO THE MANUFACTURE OF STEEL SHEET PILING OF ZED OR LIKE-SHAPED SECTION, The Tata Iron and Steel Company, Ltd., of Jamshedpur, Bihar, India.

This invention relates to a method of manufacturing of steel sheet piling of Z-shaped section or like section with locking arrangements at the extremities of the horizontal arms. Rolling of Z section in a single operation offers considerable difficulties, in



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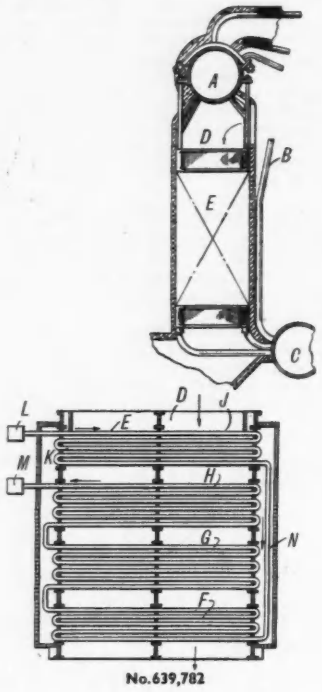
that a large-size rolling plant has to be employed. This invention aims at utilising the existing rolling mills for manufacturing the sheet piling without involving any expensive modifications. Referring to the upper drawing, the structure of steel sheet piling is according to the invention built up of two

rolled T-shaped sections *A* and *B*, which form the side members and a flat bar section *C* constituting the middle section. As the two sections *A* and *B* are of the same shape and dimensions, it is obvious that only one rolled T section is used for both. On the other hand, if the two members *A* and *B* are of different shapes as shown in the lower view, where a self-interlocking arrangement is provided at the ends of the members for joining with similar adjoining sections, then the members *A* and *B* will have to be rolled independently by separate rolls. The ends of members *A* and *B* are of V or similar section. The ends of the middle member *C* are correspondingly shaped so that when the ends are joined two V or like-shaped welding channels marked *F* and *G* are formed at the joints and in these channels welding metal is deposited. Referring to the lower view, which shows light section steel sheet piling having different locking arrangements at the ends, it will be noticed that the ends of the members *A* and *B* which join the middle member *C* are tapered or chamfered, and likewise the joining ends of the member *C* are also tapered, so that at each joint only one V-shaped welding channel *F* is formed and in the said channels welding metal is deposited as shown.—*June* 28, 1950.

STEAM GENERATORS

639,782. April 29, 1947.—IMPROVEMENTS IN OR RELATING TO A STEAM BOILER, Combustion Engineering-Superheater, Inc., of 200, Madison Avenue, New York, U.S.A.

This invention relates to heat transfer apparatus and particularly to a new and improved arrangement of the heat transfer surface of an economiser for heating water in a boiler with the surface so disposed as to minimise corrosion. The drawings show a sectional elevation of a part of a boiler and an enlarged elevational view illustrating the arrangement of the surface of the economiser. *A* designates the steam and water drum of a boiler which is connected by steam generating tubes *B* to the lower water drum *C*. The gases of combustion after having passed over the steam generating surface flow through the offtake *D* and yield further heat to the heat-absorbing surfaces of the economiser or water heater which is designated as a whole by *E*. In accordance with the invention, the tubes of the economiser are divided into two units, the first of which comprises sections *F*, *G* and *H* which are interconnected for series flow of the water therethrough, and the second of which comprises a section



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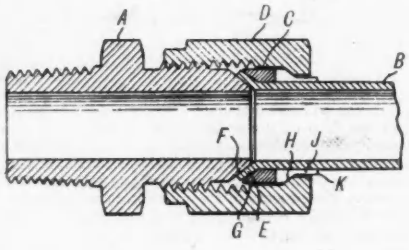
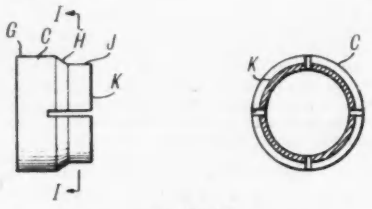
J which is arranged in the portion of the flue where the gases flowing through the offtake *D* are hottest. The economiser consists of a series of tubes *K* interconnected at adjacent ends by return bends and with the extreme ends of the elements connected to the inlet and outlet headers *L* and *M*, respectively. The cool water passing into the tubes *K* from the inlet header *L* first enters the economiser unit *J*, which is located where the gases are hottest, and on leaving this unit flows through the tube *N* to the section *F* which is located at the point in the offtake *G* where the gases are coolest. From the section *F* the water flows progressively upward through the sections *G* and *H* to the outlet header *M* with the gases and water flowing countercurrent to each other as in a conventional economiser. By providing that the economiser unit *M* is located in the hottest portion of the offtake and conducting the water heated therein to that section which is located at what is ordinarily the coldest part of the gas passage and the cold end of the economiser, the corrosion that usually takes place in the section *F* is minimised because the fluid supplied thereto has been preheated to a point which is ordinarily above the dewpoint of the gases. While this arrangement may somewhat reduce the amount of heat which can be recovered as compared with the usual counterflow arrangement, the benefit obtained by minimising corrosion more than offsets the small loss in heat recovery.—*July* 5, 1950.

TUBE AND PIPE COUPLINGS

637,940. February 24, 1948.—TUBE COUPLING SLEEVE, George Victor Woodling, of 925, Euclid Avenue, Cleveland, U.S.A., formerly of 1340, Union Commerce Building, Cleveland, 14, U.S.A.

According to this invention, there is provided a coupling device for a tube with first and second coupling elements to be connected, the first coupling member having a tapered annular surface and the second coupling member having an annular inner surface terminating in an internal annular clamping portion, and a clamping sleeve surrounding the tube and mounted in the second coupling member, the sleeve having at one end an annular body portion for engaging the tube and a plurality of spring fingers. The coupling device comprises a first coupling element *A*, a tube *B*, a clamping sleeve *C* surrounding the tube, and a second coupling element or sleeve nut *D*, which is adapted to press the





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clamping sleeve against the flared end *E* of the tube. The left-hand end of the first coupling or fitting element *A* is provided with threads. The right-hand end of the coupling element is also provided with threads to which is attached the second coupling member or compression nut *D*. The right-hand end of the coupling element *A* is provided with a bevelled abutment end *F*, against which the flared end of the tube is tightly fastened by means of the clamping sleeve *C*. The left-hand end of the clamping sleeve (see lower views) comprises an annular end portion *G* having an internal conical surface which abuts against the flare of the tube. Extending rearward of the annular end portion *G* is a tapered intermediate portion *H* and a tail end portion *J*. The tapered intermediate portion, the tail end portion and a part of the end portion are slotted to form rearward extending spring clamping fingers *K*, which clamp the tube at a point remote from the flared end of the tube for resiliently supporting the tube against vibration and fluid shock.—*May* 31, 1950.

A SELF-CONTAINED FLEXIBLE SHAFT.—A flexible shaft, now being made by E. C. Hopkins, Ltd., 99–100, Broad Street, Birmingham, is designed for attachment to drill chucks, motor spindles, power take-offs, or any rotating spindle on existing equipment. It is intended for performing all duties of a normal power unit driven flexible shaft and using the existing plant installation to provide the necessary driving medium. The shafts are supplied from ⅜in to ½in diameter and have a flexible inner cable with a rubber-covered outer casing, complete with a hand piece at one end and a housing at the other end, which can be attached to any type of rotating spindle.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Fri., Sept. 29th, to Sun., Oct. 1st.—Chemical Works Safety Conference at Scarborough.

British Association

Wed., Aug. 30th, to Wed., Sept. 6th.—Annual meeting in Birmingham.

Institute of Metals

Mon., Sept. 18th, to Fri., Sept. 22nd.—Forty-Second Annual Autumn Meeting at Bournemouth.

Institution of Metallurgists

To-day to Sat., Sept. 30th.—Science Museum, South Kensington, London, S.W.7, Exhibition, "Metals in the Service of Mankind," weekdays, 9.30 a.m. to 6.30 p.m.; Sundays, 2.30 p.m. to 6.30 p.m.

Institution of Mining and Metallurgy

Tues., Sept. 19th, to Sat., Sept. 23rd.—Conference on Wire Ropes in Mines, at Ashorne Hill, Leamington Spa, Warwickshire.

Scientific Instrument Manufacturers' Association

Tues., Sept. 5th, to Fri., Sept. 8th.—Exhibition and Symposium at the Examination Hall, Queen Square, London, W.C.1.

Contracts

DURING the past month the British Electricity Authority has placed contracts for power station work, plant and equipment amounting in the aggregate to £2,296,981. The principal contracts include Acton Lane "B" power station, foundations (Sir Robert McAlpine and Sons, Ltd.), and reinforced concrete cooling tower (J. L. Keir and Co. (London), Ltd.); York power station, demolition and reconstruction (Sir Robert McAlpine and Sons (Newcastle-upon-Tyne), Ltd.); Uskmouth power station, superstructure (John Morgan (Builders), Ltd.).

Personal and Business

MAJOR GWILYM LLOYD GEORGE has joined the board of the Superheater Company, Ltd.

MAJOR F. A. BUMPUS has been appointed acting managing director of Blackburn and General Aircraft, Ltd.

MR. ROBERT F. FRYARS has been re-elected chairman of the British Transport Vehicle Manufacturers' Association.

MR. A. W. STEVEN, Captain H. J. Kennard, R.N. (ret.), and Mr. G. Muirie have retired from the board of Allied Ironfounders, Ltd.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., announces with regret, the resignation of Mr. R. E. L. Izod, A.M.I.Mech.E., director and British sales manager.

THE STEEL COMPANY OF WALES, Ltd., states that Mr. W. J. S. Roberts, F.I.M., has been appointed chief metallurgist at the new cold reduction plant and tinplate works at Trostre.

MR. F. W. BAUER, A.M.I.Mech.E., M.Inst.F., formerly chief engineer of La Mont International Association, Ltd., has joined the board of Bouëllat Engineering, Ltd., 167, Millbank, London, S.W.1.

BRITISH JEFFREY-DIAMOND, Ltd., Wakefield, states that its business in South Wales is now handled by its own branch office at Dock Chambers, Bute Street, Cardiff (telephone Cardiff 1070). Mr. F. Jackson is the district technical manager.

LANG PNEUMATIC, Ltd., Victory Works, Wolverhampton, announces the appointment of Mr. Leslie A. Boobyer as area sales manager in London and the Home Counties. His address is 3, River Avenue, Palmers Green, N.13 (telephone, Palmers Green 5848).

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH announces that from August 14th, the address of Sir Claude Inglis, C.I.E., and the Hydraulics Research Organisation will be Mitre House, 177-183, Regent Street, London, W.1 (telephone Regent 1881).

THE MINISTRY OF TRANSPORT announces that Mr. J. Jarvie is retiring, at his own request, from the position of Engineer Surveyor-in-Chief, and is being succeeded by Mr. F. J. Colvill, deputy Surveyor-in-Chief. Mr. F. J. Welch, principal officer of the Mercantile Marine Survey Service at Belfast, will be the new deputy Surveyor-in-Chief.